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An Economic Evaluation of Capacity Issues in the Potential Joint Track Usage Territory Between Kamloops and Mission City, British Columbia

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AN ECONOMIC EVALUATION OF CAPACITY ISSUES IN THE POTENTIAL JOINT TRACK USAGE TERRITORY BETWEEN KAMLOOPS AND MISSION CITY, BRITISH COLUMBIA

by

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FOREWORD

This report is a follow up on the work undertaken by the Joint Track Study Task Force in examining the costs and benefits of increasing capacity in the very heavily used rail corridor stretching between Kamloops and Mission City, British Columbia.

This study introduces and utilizes methodology which has the potential to fine tune the benefit and cost estimates resulting from capacity expansion strategies in this and other similar situations.

Any opinions which are expressed are those of the author, and do not necessarily reflect those of the Canadian Transport Commission.

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The author, however, assumes full responsbility for the analysis and any errors that may be contained in this paper.

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CHAPTER I
INTRODUCTION

This study is the second in a series which is intended to examine the feasibility of developing an independent, cost effective ability to assess the cost and capacity implications of the changing nature of rail freight operations in Canada at the Research Branch of the Canadian Transport Commission. It follows and expands upon existing work, described below, examining the costs and benefits of increasing capacity in the very heavily used rail corridor stretching between Kamloops and Mission City British Columbia.

This chapter provides an overview of the background work leading up to this study and contrasts the working assumptions and methodology used here with work previously undertaken.

1. BACKGROUND

In 1973, the Western Economic Opportunities Conference discussed the technical feasibility and financial viability of joint track operations in the territory between Kamloops and Mission City, British Columbia. Subsequently, Transport Canada completed a preliminary study of joint railway operations at this and several other locations. In that study, it was recommended that futher work be done in this area to develop and resolve many of the details of the capacity, cost and environmental impacts of potential joint track and other alternatives.

Subsequently, in 1984, the Canadian Transport Commission, Transport Canada, the Provinces of British Columbia, Alberta and Saskatchewan, CN Rail and CP Rail agreed to investigate these issues. The resulting Joint Track Usage Study (Delcan, 1985), examined five general options:

1) limited upgrading of existing, mostly single track operations;
2) joint track usage, using existing facilities;
3) joint track usage with additional bridges and other infrastructure,
4) the implementation of a third, jointly used track; and
5) two fully double tracked railway systems.

The Joint Track Usage study was confined to an engineering and capacity analysis of the territory spanning Kamloops and Mission City. Because of the wide scope of the report, a single detailed scenario was developed representing each of these options. Further, very simple, rule of thumb methods were used in estimating the viability of each alternative.[1]

The objectives of the study were to ascertain:

a) whether capital savings and/or alleviation of environmental problems could be achieved by making joint use of the whole section, or alternatively, of selected sections of the track between Kamloops and Mission City British Columbia;

b) What construction would be required to implement JTU, its feasibility, cost, and environmental effects;

c) The extent of the potential savings in capital costs, if any;

d) What changes in operations and maintenance practices would be required, and their feasibility (Delcan, 1985, V. 1 pp. 2.2).

Because of its scope, the JTU study did not provide detailed analysis of alternatives available within each option. It did though, develop rough cost and capacity estimates and on those bases, develop recommendations for an expansion path. The study team recommended that to handle present mid term traffic projections, additional infrastructure was required. This infrastructure involved modest investments by each railroad and continued, separate operations. Joint track usage of existing facilities with moderate additional investment, and adjustment of operations was a cost effective alternative to separate operations with two sets of double tracks or the construction of a third, jointly us rack, with an expectation of large traffic growth.

2. CONTRASTING THE ORIGINAL JOINT TRACK USAGE STUDY WITH THIS WORK

The objective of this study is the fine tuning of JTU capacity and cost estimates. The study takes as given construction costs as estimated by the JTU study and extends upon the original JTU study in four ways:

1) The analysis of capacity is redone using more refined techniques than those adopted by the JTU team. The JTU team estimated capacity using 3 methods:

a) Manual simulations using string diagrams
b) Development of Single Track Occupancy (STO) times, providing estimates of bottleneck section capacities
c) Estimating mean delays per train run and developing capacities based on maximal allowable delays (Delcan

1985, Chapter 9).

Each of these provide rough estimates of overall capacity, but have a number of problems. For example, STO times do not adequately allow for the variable effect of single bottleneck point on the overall capacity of a line. Mean delay times do not allow for the additional effect of secondary delays due to congestion (i.e. trains being further delayed on a line because trains now meet or overtake each other due to a stop required to resolve a past meet or overtake).

Capacity and delay are estimated in this study using the line capacity model developed by the Canadian Institute of Guided Ground Transport (CIGGT, 1986). Results from the CIGGT model are cross checked with those developed with a simulation model developed by the Australian Bureau of Transport Economics (Rudd and Storey, 1974).

In addition, alternative capacity break points are also provided in this study. Capacity was defined by the JTU study team to occur when a delay of over an hour occurred on a hundred miles traverse. It was assumed that beyond this point, operations could not be sustained since trackage would be clogged to the point where additional tonnage or additional delay would lead to an inability to:

-handle closely spaced trains,
-recover from contingencies,
-operate indefinitely without extensive fleeting or holding trains at terminals (Delcan, 1985, V.1, p.9.5).

Two alternatives are adopted in this study.

-A traditional rule of thumb capacity break point of defining delay as the most restrictive of the following three conditions:

a) an average delay for all trains of 50% of free running time;
b) a delay a maximum of 60% of free running time for any type of train;
c) a maximum transit time of 10 hours for any train.

-The level of traffic at which the number of revenue ton miles per year are maximized. Beyond this point, the gains created by adding more traffic are more than nullified by the slowdowns thus imposed.

2) It re-examines and expands upon the two least costs scenarios studied by JTU team:

-limited upgrading of existing, mostly single track lines under separate operations;

-joint track usage, with existing facilities.

In this study, a number of intermediate steps are envisioned which can plot out intermediate alternative to the JTU study team options.

Three scenarios were examined involving separate operation and limited upgrading of the existing lines:

-the JTU study team recommendations involving a limited number of new sidings, some double tracking and re-engineering of CN siding turnouts to allow for faster turnout speeds for trains moving to and from sidings.

-Planned CN expansion in this area involving the placement of short intervals of double trackage at strategic locations. Using the principles behind the CN program, a similar scheme was developed for CP trackage.

-A mix including CN expansion plans and the JTU recommendation that sidings be re-engineered to allow for

faster turnout speeds.

Two scenarios were developed in examining joint track usage, with limited upgrading of existing facilities;

-Channelling traffic where ever possible for uni-directional movement. Since the CN line has less extreme grades and curvature in this area, this trackage would utilized for westwardly moving traffic, which includes heavily loaded bulk commodity trains. CP track would be utilized for lighter, eastward movements. Upgrades would be limited to improving the crossover between CN and CP track at Mission City to allow for more intensive use and extending CN sidings to allow for the longer CP train lengths when all traffic had to be channelled along the CN track.

-The addition of crossovers which could be intensively used at two junctions along this route to allow for continued two track operations over large portions of this trackage when was required.

3) A major depa·ture of this study from the original JTU work is in the estimation of interference costs associated with present traffic and additional traffic, under the different operating circumstances described above. Estimated capacity limits are supplemented with estimates of operating costs. Changes in track configuration. The benefits of changing roadway configurations in terms of changing interference and related costs are therefore estimated. These include reductions in railway equipment, maintenance activity, fuel and labour inputs to handle the delays generated by new train/roadway configurations.

4) In conjunction with estimating a feasible physical maximum capacity, benefits under varying traffic levels are also estimated. The traffic levels used are based upon projections of revenue tonnage through the next decade. These are compared

to the operational and capital costs of the alternatives proposed. The conclusion of this study, thus provides fuller indications of returns on alternative railway, and possibly public investments.

3. OBJECTIVES

The implications of additional capital investment in railway plant are posed here in terms of the tradeoff between the combination of increments in capacity and savings in operations, and the costs of the investment. The JTU study of capacity addresses the issue of the costs of providing an adequate and reliable infrastructure to handle various traffic loads, while this study addresses the additional issues which contribute to an efficient (in terms of a contributing towards maximizing return on investment) infrastructure.

In assessing the adequacy, reliability and efficiency of railroad operations there is an additional need of estimating the nature of traffic demands. In this regard, a review is provided of present projections of traffic volume on the JTU route. This presentation also incorporates operational and structural changes occuring in railway operations in this area. For example, CN's Western Expansion plans involves the upgrading of an alternative route for bulk commodities moving towards to export position on the west coast. Shifts in grain production and transportation patterns and potential growth in coal production in north east British Columbia rather than solely in Southeastern British

Columbia could have considerable effects on capacity expansion requirements in this area. The benefits of increased capacity and decreased costs are conditional upon expected traffic levels. Therefore these benefits are posed in terms of estimated present traffic levels and presently conservative and optimistic views of traffic in 1990 and 1995.

4. CONTENTS

In the following, present railway operations and plant are first described. This is followed by present and near future estimates of traffic levels in this region. The alternatives summarized above are then reviewed and cost estimates, taken from the Joint Track Usage Study are then provided. This is followed by a brief overview of how capacity estimates were derived and the benefits of reducing interference estimated. Finally, results are described and a recommendation is provided on the basis of maximizing expected return on the combined investments of the two railway companies.

CHAPTER II
OPERATIONS AND GROWTH POTENTIALS IN THE JOINT TRACK USAGE TERRITORY

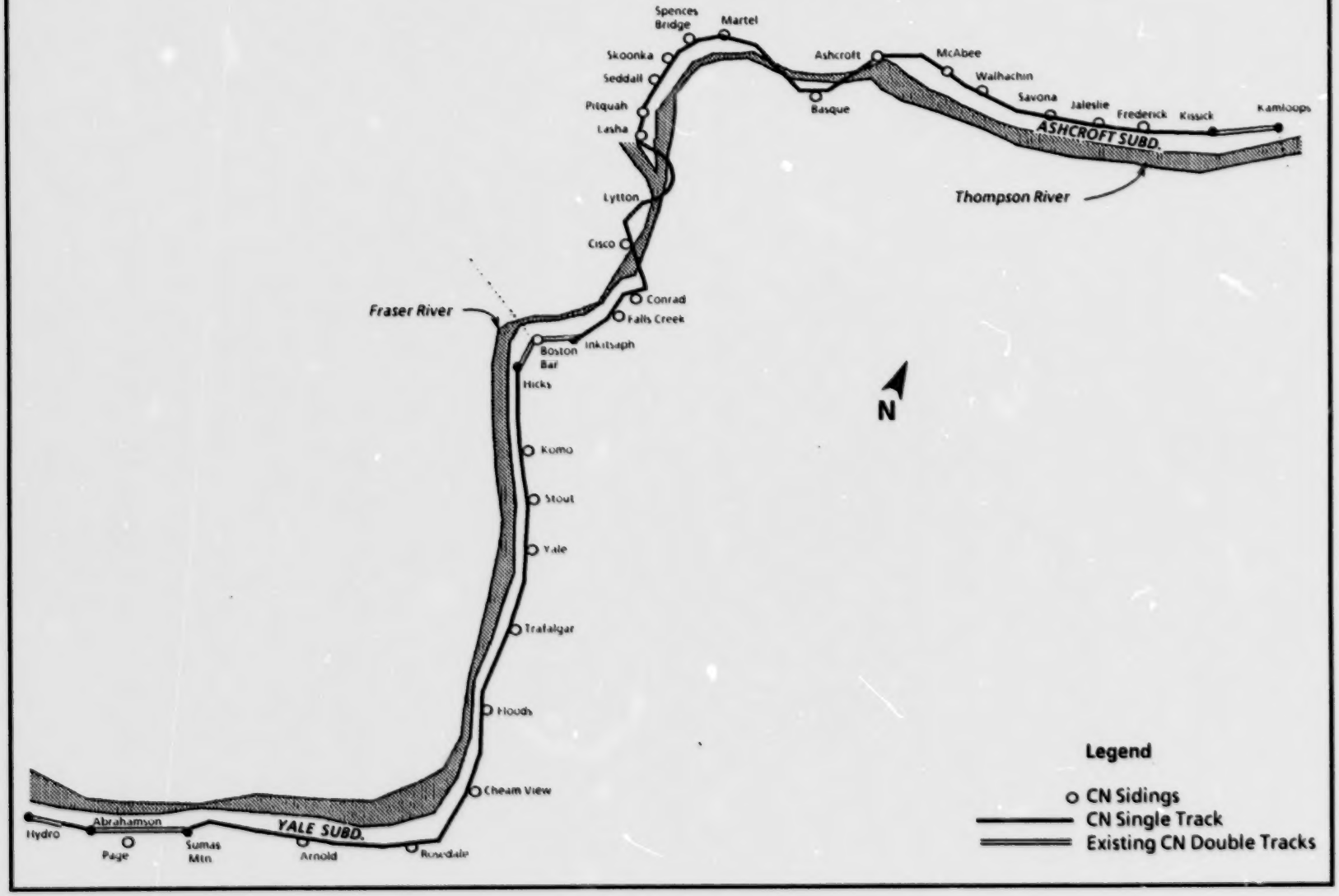
1. CN RAIL
a. Present Operations
i. Track and Signalling

The area under consideration includes the mainline between Kamloops and the CN junction with the Rawlinson Subdivision, 14.3 miles east of Thornton Yard, in Vancouver. At this point, a large proportion of CN bulk traffic moves from the main line to allow delivery at Roberts Banks. It includes all of the Ashcroft Subdivision and 101.7 miles of the Yale, totalling 227.2 miles. Trackage follows the Thompson Canyon to mile 99.7 of the Ashcroft and the Fraser Canyon for the remaining 127.2 miles. Figure 1, (from the JTU study), is a map indicating existing track configuration.

The CN line includes 31 tunnels covering 3.9 miles, a large number of extreme curves of up to 8 degrees and 56 bridges, including 9 which span the Thompson and Fraser Rivers. Heavy train movements, affected by the ruling grade are almost exclusively in the westbound direction. The ruling westbound grade is .46% and occurs at a short span of .5 miles on the Yale Subdivision. An extending grade of .4% occurs between mile 4.9 and 7.6 of the Ashcroft. To eastbound traffic, the ruling grade of .5% occurs on the Ashcroft Subdivision. Generally, this area is characterized by a descent to the west. The extreme

Figure 1

SIDINGS AND DOUBLE TRACK LOCATIONS ON THE CN YALE AND ASHCROFT SUBDIVISIONS



number of bridges, tunnels and the high degree of curvature is necessitated by the very steep slopes and confines of the Thompson and much of the Fraser Canyons in conjunction with prior presence of the CP right of way.

The CN line is presently predominantly single tracked. Sidings are spaced at approximately 7 mile intervals in single track territory. Presently, there are 3 relatively short sidings of length 5740-5780 feet, with a capacity of approximately 94-95 standard hopper cars (plus 2 locomotives and a caboose). All are located on the Yale Subdivision, between mile 44.0 and 76.5. There are 6 sidings of lengths between 6040-6080 feet located on the remainder of the Yale Subdivision, and at Walhachin and Seddall on the Ashcroft which are limited to 99-100 standard hopper cars.

Double track segments occur on the 9.3 miles of track directly west of Kamloops Yard, the 4.0 miles directly to the east of Boston Bar, and with the exception of a 3.6 mile stretch, the trackage between mile 86.7 and 101.7 on the Yale. In total, 10.9% of this line is presently double tracked. In addition, CN is about to complete 4 miles of double track directly to the west of Boston Bar increasing the proportion of double track to 12.7%.

The distribution of double track and sidings on the CN line, as of January 1, 1986, is summarized in Table 1 and shown in Figure 1.

Traffic control is handled through a centralized train control system located at Kamloops. The introduction of

TABLE 1
CN TRACKAGE AND SPEED STATISTICS--ASHCROFT AND YALE SUBDIVISIONS

Station	Mileage	End Point	Distance Between	Speed Limits Passenger	Freight	Freight Operating Speed
ASHCROFT SUBDIVISION						
Kamloops	0.0					
Mann	0.7	Yard	0.7	20.0	20.0	
Kissick	9.3	Two Tracks	8.6	46.0	43.8	28.7
Frederick	13.8	Siding	4.5	35.0	31.2	30.5
Jaleslie	19.4	Siding	5.6	35.0	30.0	27.0
Savona	25.7	Siding	6.3	35.0	32.9	29.6
Walhachin	32.6	Siding	6.9	36.1	35.4	31.7
McAbee	40.0	Siding	7.4	38.9	35.6	29.0
Ashcroft	48.7	Siding	8.7	40.0	30.0	30.6
Basque	58.4	Siding	9.7	40.0	30.0	33.3
Martel	68.4	Siding	10.0	39.2	34.2	27.4
Spences Bridge	74.8	Siding	6.4	36.7	33.3	26.7
Seddall	82.8	Siding	8.0	38.5	32.5	30.9
Pitquah	89.5	Siding	6.7	36.6	33.1	22.1
Lasha	96.5	Siding	7.0	35.0	26.7	27.0
Cisco	101.0	Siding	4.5	34.7	30.3	27.0
Conrad	105.7	Siding	4.7	35.0	30.4	23.5
Falls Creek	110.2	Siding	4.5	35.0	27.0	27.0
Inkitsaph	115.3	Siding	5.1	35.0	32.8	30.6
Martinson	121.5	Two Tracks	6.2	35.6	29.4	20.7
Boston Bar	125.5	Yard	4.0	20.0	29.7	28.5
YALE SUBDIVISION						
Boston Bar	0.0					
Hicks	3.1	Siding	3.1	26.5	23.2	14.3
Komo	10.2	Siding	7.1	30.0	25.0	25.1
Stout	18.3	Siding	8.1	38.3	27.9	27.0
Yale	26.7	Siding	8.4	36.1	26.1	25.2
Trafalgar	36.0	Siding	9.3	47.1	38.6	37.2
Floods	44.0	Siding	8.0	45.6	38.8	34.3
Cheam View	54.1	Siding	10.1	53.1	46.8	43.3
Rosedale	65.9	Siding	11.8	49.8	43.0	37.3
Chilliwack	71.8	Siding	5.9	68.6	60.0	39.3
Arnold	76.5	Siding	4.7	70.0	60.0	47.0
Sumas Mountain	86.5	Two Tracks	10.0	49.8	40.6	33.3
Abrahamson	90.9		4.4	60.9	51.9	52.8
Glen Valley	94.5	Two Tracks	3.6	40.0	36.7	36.0
Hydro	101.7	Two Tracks	7.2	61.5	52.4	33.2
TOTAL	227.2			42.4	36.0	30.0
ASHCROFT	125.5			37.6	32.3	26.0
YALE	101.7			38.4	40.5	35.0

intermediate signalling has recently been completed in CN territory on the Ashcroft Subdivision and is to be completed within the next couple of years on the Yale. Signals are to be spaced at a distance of approximately 1.3 miles. Spacing between trains following in the same direction can therefore be reduced to a double block of 2.6 miles. This allows for fairly close spacing of trains and a capacity to fleet high densities of trains as required.

Table 1 also shows the speed limits for freight and passenger trains in this area. Given the weight/power ratio utilized by CN, in conjunction with the high amount of curved and graded track, these are not good indications of maximum attainable speed, particularly for fully loaded trains. Table 1 therefore also provides average operating speeds for passenger and loaded westbound freight trains operating in this area in 1984, which are considerably lower than the free running times reports in Table 1.

The low average operating speeds shown in Table 1 are a result of the high proportion of curved track, numerous grades and changes in grade. Through much of the terrain covered, speeds average in the 25-30 mile per hour range.

Another reason for the lower average operating times is the large amount of maintenance and related down and slow order time occuring in this territory. Three factors contribute to this:

1) Certain areas of track are prone to occasional washouts,

rock and snow slides slides and heavy snowfall. These are rare and usually affect operations for a maximum of a week every few years.

2) Heavy car loadings, frequent grade changes and high proportions of curved track contribute to the need for frequent tie and rail replacement.

3) There are high levels of two way traffic along this track. In 1984, 54.8 million gross tons moved over this line.

In order to reduce these requirements, CN has invested in numerous grade and river bed stabilization projects as well as constructing a number of rock and snow sheds. CN has installed 136 pound head hardened continuously welded rail and uses concrete ties on curves of over 2 degrees and tangent track adjacent to all extreme curves. This study, in accord with the report of the JTU study team, assumes that 25% of summer track time is allocated to maintenance and 8% is allocated during the remaining nine months of the year.

ii. Traffic

Daily traffic levels and trains opeating statistics for 1984 are summarized in Table 2. During that time, approximately 18 trains operated over the two subdivisions daily. Most traffic was composed of loaded solid, unit and through trains, travelling westbound and largely empty returns travelling eastbound. Approximately 2 express freight trains move in each direction daily. Beginning in June, 1985, a daily passenger train moved

across this territory in each direction. Local freights were very infrequent on the Ashcroft and ran roughly twice weekly on the Yale subdivision.

TABLE 2

ASHCROFT AND YALE SUBDIVISIONS 1984
OPERATING AND TRAFFIC STATISTICS*

Type	Daily Trains	Cars	Tonnage Gross	Net	# of Locos	Tons /H.P.	Av. Speed
ASHCROFT SUBDIVISION							
Outbound							
Passenger	1.00	9.7	1063	N.A.	2	.3	
Locals	0.02	94.8	7536	5166	2	1.2	18.7
Express	1.81	83.0	6394	4320	3	0.8	23.6
Through	3.11	99.6	9786	7297	2	1.7	15.6
Solids	3.76	99.3	12270	9290	3	1.8	16.6
Inbound							
Passenger	1.00	9.7	1063	N.A.	2	.3	
Locals	0.01	95.6	4899	2509	2	0.9	20.2
Express	1.42	75.5	4415	2528	3	0.6	24.0
Through	3.44	100.0	3250	750	2	0.6	19.5
Solids	3.74	100.1	3634	632	3	0.5	20.9
YALE SUBDIVISION TO RAWLINSON SUBDIVISION							
Outbound							
Passenger	1.00	9.7	1063	N.A.	2	.3	
Locals	0.22	37.2	959	216	1	0.5	11.2
Express	1.81	83.0	6394	4320	3	0.8	23.6
Through	3.09	99.6	9786	7297	2	1.7	11.8
Solids	3.75	99.3	12275	9296	3	1.8	16.6
Inbound							
Passenger	1.00	9.7	1063	N.A.	2	.3	
Locals	0.22	36.3	831	104	1	0.5	11.3
Express	1.42	75.5	4415	2528	3	0.6	24.0
Through	3.44	100.0	3254	750	2	0.6	19.5
Solids	3.74	100.1	3635	632	3	0.5	20.9

* Passenger data is based upon 1985 figures.

In total, during 1984, approximately 6700 trains travelled

over the Ashcroft Subdivision, and over 6800 on the Yale, carrying over 24 million revenue tons westbound and approximately 3 million revenue tons eastbound.

CN solid trains primarily carry bulk freight primarily of grain, coal, potash and sulphur and carry this most of this material to export position. Bulk traffic is split between Vancouver and Roberts Bank. These trains are frequent and heavy, averagings over 12 thousand gross tons (MGT) moving westbound. Some bulk, primarily Phosphoric rock moves eastbound, but by and large, eastbound bulk trains move back empty, averaging just over 3.6 MGT's. Through trains move westward carry heavy freight, including wood products and some bulk commodities (grain and potash), and average 9.8 MGT's. Eastbound through trains also tend to move empty eastbound, although some wood products also move in this directions, averaging just over 3.2 MGT's. Express trains primarily carry intermodal traffic moving in both directions and automobile products, westward domestically produced cars for the Vancouver market and eastern Asia imports for the rest of Canada. Traffic, in terms of tonnage carried moves in a ratio of 3:2 westbound to eastbound, so that westbound trains are somewhat heavier, averaging 6.4 MGT to 4.4 MGT's eastbound.

In 1984, power was supplied by SD40, 3000 horsepower locomotives. On average, approximately 3 were assigned to bulk and express trains, 2 to through trains. In 1985, with the introduction of newer, SD50, 3300 horsepower units, CN has

reduced the number of units on bulk trains to 2 of these higher horsepower units. Because of low grades, CN is able to bulk through this area with very high tonneage to horsepower ratios, ranging from 1.7 to 1.8 for westbound through and solid trains. These ratios would be insufficient to negotiate ruling grades on CP trackage.

b. Potentials for Growth and Shifting Traffic

The Western Action Committee (WESTAC) has recently published projections of traffic growth for bulk traffic the next decade (WESTAC, 1986). These projections are tempered by a great deal of uncertainty. As a result, WESTAC projections for grain, coal and potash moving to west coast ports are provided for a range of between 1% and 4%. In addition, with decreases in supply, export of sulphur is expected to decline during this period. Growth projections for other commodities moving to the west coast by rail, provided by Transport Canada, indicate growth within this range. Table 3 indicates estimates based on these sources to west coast ports.

In addition, CN has reported that it expects that much of its future growth in grain traffic to be handled primarily through the Port of Prince Rupert (CN, 1985). By 1990, it is assumed here that there is a shift of 1.4 million tons of grain to Prince Rupert. Coal traffic to Prince Rupert from Northeastern British Columbia, further, is to some degree, in competition with coal moving to Roberts Banks and Vancouver, thus

to some extent damping traffic through the potential joint track usage territory.

TABLE 3

PROJECTED NET TONNAGE GROWTH OF EXPORT TRAFFIC TO WEST COAST PORTS UNDER WESTAC OPTIMISTIC AND PESSIMISTIC GROWTH SCENARIOS

	ACTUAL 1985	PROJECTED 1990		PROJECTED 1995	
VANCOUVER		OPTIM.	PESSIM.	OPTIM.	PESSIM.
GRAIN	10.2	16.0	10.5	17.6	10.3
FOREST	6.3	6.7	6.7	7.0	7.0
SULPUR/POTASH	9.8	11.8	9.7	14.4	10.2
METAL ORE	.9	.8	.8	.8	.8
COAL	21.4	23.5	21.3	27.8	23.4
PETROCHEM	4.0	4.2	4.2	4.4	4.4
CHEM	5.0	6.1	5.3	7.4	5.5
MISCEL	4.1	4.6	4.6	5.6	4.8
TOTAL	61.7	73.5	62.9	84.9	66.5
PRINCE RUPERT					
GRAIN***	1.4	2.8		3.3	2.9
COAL	8.3	8.4		10.2	8.8
TOTAL	9.7	11.1		13.5	11.7

* Developed from WESTAC (1986), Vancouver (1986) and Transport Canada (1985)
** Sulphur supply is expected to provide a constraint on exports so that movements in this commodity are expected to drop in the next few years
*** Prince Rupert projections indicate expected shifts of growth in CN grain traffic from the port of Vancouver

Table 4 shows the implications of these projections for CN movements to Vancouver, assuming no shift in total market share.

In 1984, CN moved 41.4% of the tonnage loaded in the Vancouver area. Given no loss in market share, and projected growth in traffic of between 1% and 4% in bulk and related commodities Transport Canada forecasts in other area, and a shift

in grain to Prince Rupert, this proportion would range from

TABLE 4
CN PROJECTED NET TONNAGE AND TRAIN FLOWS THROUGH JTU TERRITORY
UNDER OPTIMISTIC AND PESSIMISTIC GROWTH SCENARIOS

		NET TONNAGE			
	ESTIMATED 1985	PROJECTED 1990		PROJECTED 1995	
		OPTIMISTIC	PESSIMISTIC	OPTIMISTIC	PESSIMISTIC
TOTAL	25.5	30.6	25.7	34.9	27.0
BULK	15.4	17.7	14.8	20.7	15.8
GRAIN	5.2	6.8	4.0	7.0	3.8
OTHER WEST	9.0	11.5	9.7	12.6	10.0
OTHER EAST	1.1	1.4	1.2	1.6	1.2
SHARE OF TOTAL TRAFFIC	41.4	41.6%	40.8%	41.0%	40.6%*
TRAINS PER DAY*					
WESTBOUND SOLID	3.8	4.5	3.6	5.4	3.9
WESTBOUND OTHER	4.9	6.5	6.5	7.4	7.4
TOTAL ASHCROFT	19.4	24.0	22.2	27.6	24.6***
TOTAL YALE	20.4	24.4	22.6	28.0	25.0

* 1984 SHARE OF TOTAL TRAFFIC ASSUMED WITH SHIFT OF GRAIN TRAFFIC TO PRINCE RUPERT LEADING TO DECLINE IN SHARE OF THIS MARKET

** ASSUMING NO CHANGE IN THE DISTRIBUTION OF TRAFFIC AMONG THROUGH FREIGHTS AND EXPRESS TRAINS AND NO INCREASE IN TRAIN CAPACITY

*** ASSUMING EASTBOUND AND WESTBOUND TRAFFIC IS SYMMETRIC, TWO PASSENGER TRAINS SHARE TRACKAGE DAILY AND LOCAL TRAFFIC ALONG THE YALE REMAINS AT PRESENT LEVELS

between 40.8 and 41.6%. This proportion would decline with further shifts of grain traffic to Prince Rupert to between 40.6 and 41.4 in 1995.

In terms of bulk commodity traffic moving to Vancouver, this would involve a change of between -.6 and 2.3 million net tons.

Given present bulk train capacities, this would entail a maximum of an additional .7 westbound solid trains and an equal number of return eastbound empties. By 1995, with some additional growth in bulk traffic to Prince Rupert, bulk traffic is projected to grow by between .4 and 5.3 million revenue tons, requiring an additional 1.6 solid trains moving westbound and corresponding empties. Projected growth in other westbound traffic in 1990 would lead to an additional westbound movements of 3.6 million revenue tons in other commodities, in 1995, 5.7 million revenue tons. This could lead to growth in through and priority trains of approximately 1.6 trains per day moving westbound by 1990 and approximately 2.5 trains per day by 1995. Growth in train traffic in this latter area is conditional upon traffic mix and the resultant number of express and other train traffic. Given the high number of empty returns, bulk and other traffic growth eastbound could be easily handled by filling available empty cars, moving in trains moving eastbound from Vancouver and Roberts Bank.

In total then, by 1990, optimistic growth projections with shifting traffic to Prince Rupert could lead to approximately 1.5 additional westbound trains, and 3 to 4 by 1995, with corresponding return movements. Some of this growth could be handled through the use of longer, heavier trains, in co-ordination with the extending of sidings in this territory. This could be expedited in the near future with the planned adoption

of a new generation of efficient, higher horsepower locomotives.

2. CANADIAN PACIFIC OPERATIONS

a. Present Operations

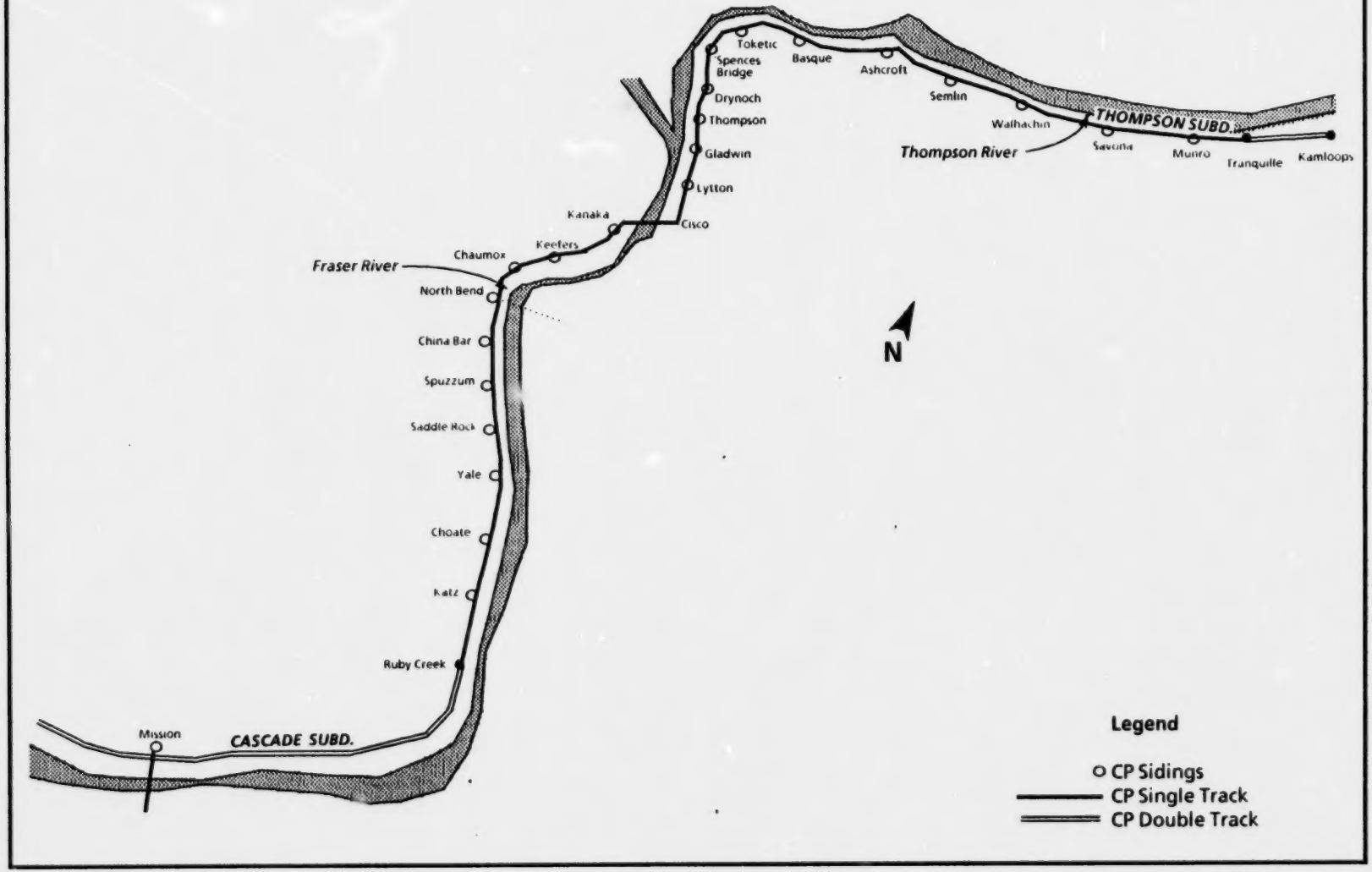
i. Track and Signalling

The area under consideration includes the mainline between Kamloops and the CN junction with the Mission Subdivision, 26.4 miles east of Coquitlam Yard at Vancouver. At Mission, a large proportion of bulk traffic destined for Roberts Bank moves off the mainline. It includes all of the Thompson Subdivision and 87.3 miles of the Cascade, totalling 208.7 miles. Trackage follows the south bank of the Thompson River to the Fraser Canyon at mile 97.7 of the Thompson, near Lytton and then follows the western bank of the Fraser River to mile 101 where it crosses to the west bank for the remainder of the trip to Coquitlam yard (See Figure 2).

The CP line includes 27 tunnels covering 2.0 miles, a large number of extreme curves of up to 12 degrees and 36 bridges. As with CN, heavy train movement, affected by the ruling grade is primarily moving westbound. The ruling westbound grade occurs between mile 101 and 102.7 of the Thompson and averages 1 degree with short spans between 1.3% and 1.45%. A second extreme grade of .9% occurs on the Thompson between miles 114.3 and 116, with short spans between 1.075 and 1.15% and a third extreme grade occurs on the Cascade between mile 13.5 and 15.3, averaging .75% with short spans of 1% and 1.05%. Moving eastbound, ruling grades occur between mile mile 42.7 and miles 40.8 of the

Figure 2

SIDINGS AND DOUBLE TRACK LOCATIONS ON THE CP THOMPSON AND CASCADE SUBDIVISIONS



Cascade, with an average of 1.02%, and at two points on the Thompson, between miles 34.7 and 32.3 and mile 84.7 and 83.6 which both average 1%. As with CN, heavy train movement is dominantly in the westward direction.

CP trackage, which was engineered earlier than CN, contains fewer bridges and tunnels, but because it was originally build in an era where costs of extreme grade and curvature were less significant in comparison to the capital outlay required, it is characterized by more extreme conditions than the CN line. It too, then is heavily affect by the very steep slopes and confines of the Thompson and much of the Fraser Canyons.

CP is predominantly single tracked. Sidings in single track territory are spaced approximately at 7.5 mile intervals in single track territory. Sidings are a minimum of 7045 feet and can handle hopper car trains of over 120 hopper cars (plus 5 locomotives and a caboose).

Double track segments occur on the 8.6 miles of directly west of Kamloops Yard, and all trackage west of mile 51.7 of the Cascade to Coquitlam. In total, 44.2 miles or 21.1% of the CP line is double tracked.

The location of double track and sidings on the CP line, as of January 1, 1986, is summarized in Table 5 and shown in Figure 2.

Traffic control is handled through a centralized train control system located at Kamloops to the double track section beginning at Ruby Creek. Here, trains proceed under an automated

TABLE 5

CP TRACKAGE AND SPEED STATISTICS
THOMPSON AND CASCADE SUBDIVISIONS

Station	Mileage	End Point	Distance Between	Speed Limits Passenger	Speed Limits Freight	Freight Operating Speed
THOMPSON SUBDIVISION						
Kamloops	0.0					
Benledi	3.0	Yard	3.0	39.0	39.0	12.9
Tranquille	8.6	Two Tr	5.6	37.0	36.5	33.6
Munro	16.9	Siding	8.3	28.6	28.6	26.2
Savona	25.2	Siding	8.3	36.2	36.0	29.3
Walhachin	32.1	Siding	6.9	38.6	32.7	29.6
Semlin	38.5	Siding	6.4	38.8	33.4	32.0
Ashcroft	47.3	Siding	8.8	43.9	38.9	37.7
Basque	55.9	Siding	8.6	34.9	34.9	30.4
Toketic	64.0	Siding	8.1	37.3	37.3	34.7
Spences Bridge	72.8	Siding	8.8	36.9	36.9	35.2
Drynoch	79.3	Siding	6.5	30.0	30.0	26.0
Thompson	85.6	Siding	6.3	32.5	30.0	31.5
Lytton	94.9	Siding	9.3	33.9	33.9	27.9
Kanaka	103.9	Siding	9.0	32.6	32.6	28.4
Keefers	110.8	Siding	6.9	32.2	31.4	27.6
Chaumox	116.5	Siding	5.7	35.0	31.8	24.4
North Bend	121.5	Siding	5.0	33.8	33.8	27.3
CASCADE SUBDIVISION						
North Bend	0.0	Yard				
China Bar	6.2	Siding	6.2	30.0	25.0	20.7
Spuzzum	15.5	Siding	9.3	30.0	25.0	23.3
Saddle Rock	22.0	Siding	6.5	30.0	25.0	22.9
Yale	29.0	Siding	7.0	35.1	28.9	24.7
Choate	35.6	Siding	6.6	53.2	40.0	36.0
Katz	44.9	Siding	9.3	42.4	36.1	31.0
Ruby Creek	51.7		6.8	56.7	43.1	40.8
Agassiz	58.9	Two Tr	7.2	68.2	49.4	43.2
Harrison Mills	68.1	Two Tr	9.2	60.3	48.3	39.4
Nicomen	76.7	Two Tr	8.6	51.1	42.7	36.9
Dewdney	81.6	Two Tr	4.9	57.1	48.6	42.0
Mission City	87.3	Siding	5.7	57.7	48.6	38.0
TOTAL	208.8			40.3	35.7	31.2
ASHCROFT	121.5			35.3	34.0	29.9
YALE	87.3			47.3	38.1	33.0

block system. CP is in the process of upgrading its centralized control system, and may eventually extend CTC to Coquitlam. At present, intermediate signalling is in place at roughly 1.7 mile intervals. Spacing between trains following in the same direction can therefore be reduced to a double block of 3.4 miles. This allows for fairly close spacing of trains and a capacity to fleet high densities of trains as required. The longer block length on CP territory is related to the longer train maximum train lengths that CP employs.

Table 5 also provides the speed limits for freight and passenger trains in this area. Given the weight/power ratio utilized by CP, in conjunction with the high amount of curved and graded track, these are not good indications of maximum attainable speed for trains using this area, particularly those moving fully loaded. As for CN, a column has been included indicating the free running times of fully loaded bulk trains moving westbound, based on train performance calculator results provided by CIGGT. There are, on average 12.6% below speed limits. Table 5 also provides average operating speeds for train classes operating in this area in 1982, which in turn are lower than the free running times reports.

The low average operating speeds shown in Table 5 is related to the high proportion of curved track, numerous grades, rugged terrain and short sight distances. Through much of the terrain covered, speeds average in the 25-30 mile per hour range.

Another reason for the lower average operating times is the

large amount of maintenance and related down and slow order time occuring in this territory. Three factors contribute to this:

1) Certain areas of track are prone to occasional washouts, rock and snow slides slides and heavy snowfall. These are rare and usually affect operations for a maximum of a week every few years.

2) Heavy car loadings, frequent grade changes and high proportions of curved track contribute to the need for frequent tie and rail replacement.

3) There are high levels of two way traffic along this track. In 1984, 54.8 million gross tons moved over this line.

In order to reduce these requirements, CP has invested in numerous grade and riverbed stabilization projects as well as constructing a number of rock and snow sheds. CP has also installed 136 pound head hardened continuously welded rail and uses hardwood ties on all mainline trackage.

This study, in accord with the report of the JTU study team, assumes that 25% of summer track time is allocated to maintenance and 8% is allocated during the remaining nine months of the year.

ii. Traffic

Between 1982 and 1984, traffic rose from approximately 24 trains per day to 26 per day over the 2 subdivisions. In 1982, traffic totalled 47.0 mgt's, it grew in 1983 to 51.1 and to 54.8 mgt's in 1984. As with CN, traffic moving westbound was heavily

loaded, traffic eastbound, primarily empty. In 1982, of 30.7 revenue tons moved, 86%, moving westbound.

In total, in 1982 and 1983, approximately 8800 trains moved over the CP line. This rose to 9614 in 1984. Much of the increased revenue tonnage was handled through increased car loadings and train length.

Table 6 shows that CP's traffic mix included a higher proportion of local and express traffic than for CN, although more than half loaded solid, unit and through trains, travelling westbound and largely empty returns travelling eastbound. A single passenger service moves along the CP line daily in each direction.

CP has a larger amount of local traffic than CN in this area because it services a copper and molybdenum concentrate facility in Ashcroft and a gypsum mine in Aggasiz (See Figure 2). In 1985, .6 million revenue tons moved from these mines. Express trains carried container and automobile traffic to and from central and western Canada and container traffic to and from CP's subsidiary, the Soo Line, which services much of the area directly west and north of Lake Michigan in the United States. Slow freight traffic includes woodpulp and newsprint moving from inland B.C. to Vancouver for export and chemicals, including a large amount of ethylene glycol. Included in the solid/unit train traffic is coal traffic from southeastern British Columbia and Western Alberta to Roberts Banks, and 2.8 million tons of sulphur, potash and grain.

TABLE 6

THOMPSON AND CASCADE SUBDIVISIONS 1982
OPERATING AND TRAFFIC STATISTICS

Type	Daily Trains	Cars	Tonnage Gross	Net	# of Locos	Tons /H.P.	Av. Speed
THOMPSON SUBDIVISION							
Outbound							
Passenger	1.0	12	856	N.A.	3	.2	33.3
Local	0.4	9	679	426	1	.2	33.4
Express	3.4	79	6636	4784	3	.8	23.7
Through	3.2	78	8307	6123	3	.8	18.5
Solid/Unit	3.4	105	13555	10695	5	.9	19.9
Inbound							
Passenger	1.0	12	856	N.A.	3	.2	32.6
Local	0.4	16	816	353	2	.1	36.1
Express	1.8	61	3148	1697	4	.3	27.6
Through	5.3	53	2830	1568	3	.4	19.5
Solid/Unit	3.7	103	2884	77	4	.2	23.4
CASCADE SUBDIVISION							
Outbound							
Passenger	1.0	12	856	N.A.	3	.2	33.3
Local	0.3	21	1823	1277	2	.4	16.0
Express	3.4	79	6636	4784	3	.8	23.7
Through	3.2	78	8307	6222	3	.8	18.5
Solid/Unit	3.4	105	13555	10695	5	.9	19.9
Inbound							
Passenger	1.0	12	856	N.A.	3	.2	32.6
Local	0.3	15	993	593	3	.1	20.8
Express	1.8	61	3148	1697	4	.3	27.6
Through	5.3	53	2830	1568	3	.4	19.5
Solid/Unit	3.7	103	2884	77	4	.2	23.4

Power is supplied almost exclusively by SD40, 3000 horsepower locomotives. On average, 5 units are supplied to bulk trains moving westbound. CP extensively utilizes mid train robot units. Three power units are assigned to the head of each train and 2 "lococontrol" units are assigned to the middle. CP

is presently planning to lengthen coal trains by approximately 7 cars and may follow suit with other bulk trains.[2] Express (Symbol 400 trains) and regular through freight trains (Symbol 900 trains) both move with a consist of 3 front end units. CP requires lower tonnage to horsepower ratios because of the more extreme terrain in this territory. To the east of Kamloops, power requirements are even greater, and as a result, units are removed at Revelstoke, and, occasionally at Kamloops. The fine orchestration of the general power requirements for mainline passing through the Pacific Division, has led to a situation where CP can optimize its operations through moving longer trains than CN. Coal trains, for example, are 111 units. The average for all solid and unit trains is 105 cars. As a result, CP siding lengths are considerably longer and allow further expansion to up to 120 hopper cars.

The utilization of CN trackage would allow CP to reduce its power requirements in this area, but were sidings to remain necessary, would provide train length problems. In addition, the intermediate signal system of CN would not assure sufficient spacing for safe train movement under extreme fleeting arrangements under the assumption of two block lengths between trains. Thus, trains would have to be fleeted at three block lengths, thus reducing one way operating capacity.

b. Growth Potential

Table 7 shows the implications of the growth projections provided in Table 3 on CP traffic moving to Vancouver.

In 1984, CP moved 54.9% of the tonnage loaded in the Vancouver area. Given no loss in market share, and projected growth, this proportion should increased to approximately 56% through 1995, with the shift of CN grain traffic to Prince Rupert.

Bulk commodity traffic is projected to increase by between .4 and 3.3 million tons by 1990. By 1995, bulk is projected to grow by between 1.6 and 6.8 million tons. Under the pessimistic growth projection, future growth could be handled primarily with longer trains leading to very little growth in train traffic. Under optimistic growth assumptions and present train operations, solid and unit train growth would increase by 1.8 trains westbound trains per day.

Growth in other traffic could be much more substantial, varying between 2.7 and 6.2 million tons per year. This could increase wesbound traffic by between .9 and 3.2 trains per day by 1995. A large number of potential operating changes could radically affect these figures. The most radical of these is the possible implementation of double stacked containers. More probable is the extending of express and regular through freight trains in accord with traffic growth. This option is particularly likely in co-ordination with the introduction of a new generation of higher horsepower locomotives, likely to occur

in the next year or so, and the completion of the Rogers Pass tunnel in 1988.

TABLE 7
CP PROJECTED NET TONNAGE AND TRAIN FLOWS THROUGH JTU TERRITORY
UNDER OPTIMISTIC AND PESSIMISTIC GROWTH SCENARIOS

	NET TONNAGE				
	ESTIMATED 1985	PROJECTED 1990		PROJECTED 1995	
		OPTIMISTIC	PESSIMISTIC	OPTIMISTIC	PESSIMISTIC
WEST BULK	15.4	18.7	15.8	22.2	17.0
GRAIN	5.0	9.2	6.5	10.6	6.6
OTHER WEST	16.5	19.7	17.4	22.7	18.2
OTHER EAST	2.0	2.4	2.1	2.7	2.2
TOTAL	33.9	40.8	35.3	47.6	37.4
SHARE OF TOTAL TRAFFIC	54.9%	55.5%	56.1%	56.0%	56.2%
TRAINS PER DAY WESTBOUND*					
SOLID FREIGHT	3.9	4.8	4.1	5.7	4.4
Longer Trains	3.7	4.5	3.8	5.3	4.0**
OTHER FREIGHT	8.7	10.4	9.2	11.9	9.6
THOMPSON TOTAL	25.6	31.8	28.0	37.2	30.0***
CASCADE TOTAL	25.2	31.4	27.4	36.8	29.6***

* 1985 for Cascade Subdivision, based upon 1985 unloads apportioned to CP based upon historic market shares
** Assumes that all Solid and Unit Trains are extended by 7 fully loaded hopper cars contained 100 tons of bulk
*** Assuming eastbound and westbound traffic is symmetric, two passenger trains share trackage daily and local traffic along the Thompson and Cascade remains at present levels and solid/unit train lengths increase.

Given the high number of empty returns, bulk and other traffic growth eastbound should be easily handled by increases in empty cars at Vancouver. In total then, expected growth under present operations, with no operational changes and presently optimistic changes in traffic levels, would produced an

additional 2.6 westbound trains in 1990, bringing traffic to approximately 30 trains per day and 5.0 trains in 1995, bringing traffic to approximately 35 trains daily. Changes in operations and/or less extreme growth could reduce train traffic by 1995 to approximately 30 trains per day.

CHAPTER III
CAPACITY EXPANSION ALTERNATIVES AND THEIR COSTS

1. INTRODUCTION

The Joint Track usage study provided both clear engineering and cost options and sufficient cost details to develop alternate options. In addition, it is possible, given the detailed costs given in the report, to develop estimates of alternatives to those posed in the study. In this chapter, a series of single track separate operations options and double track with basically existing facilities are reviewed and costed.

2. SINGLE TRACK OPTIONS

In adopting the STO method, a bias is introduced in the work undertaken by the Joint Track Usage study team in that a mechanism for upgrading capacity tends to follow. Since STO identifies individual bottleneck points, the JTU recommendations are directed towards alleviating these bottlenecks, primarily throught the addition of sidings and short double track segments.

To enhance smooth operations and to reduce delay times due to meets and overtakes, the JTU study team also proposed that CN turnouts be reconstructed to allow for turnout speeds in excess of 20 miles per hour, in contrast to existing limits of 15 miles per hour.

In contrast, CN simulation studies have identified short segments of double track at or near the entrance to yards and in the midst of long segments of single track which, in be co-

ordinated with dispatching logic and an intermediate signalling to allow for smooth traffic flow through. The rationale for placing double track at the entrance and exit points of yards is the requirement of all trains to accelerate and decelerate at these points, thus creating potential bottleneck points.

Along the CN Ashcroft subdivision, as Table 8 indicates, the JTU study team call for 2 new sidings and short double track segments resulting from extending 3 existing sidings, totalling 5.6 miles of additional trackage. On the Yale Subdivision, four new sidings are called for. In co-ordination with this work, new signalling, switchouts and related equipment is required.

CN, in its western expansion plans call for the building of two double track segments on the Ashcroft Subdivision, for a total of 20 miles of additional trackage. This produces double track at either end of the subdivision and at points roughly one and two thirds along the line (See Figure 3).

Along the Yale, one element of CN's expansion plan has been completed with the construction of 4 miles of double track directly west of Boston Bar. One additional double track segment is envisioned, breaking the existing single track segment at roughly the half way point.[3]

Table 8 also provides costs estimated from the Joint Track Usage Study. The joint track usage options involve considerably less new trackage, and are subsequently, considerably cheaper. Based on JTU study team 1985 estimates, the total costs for the

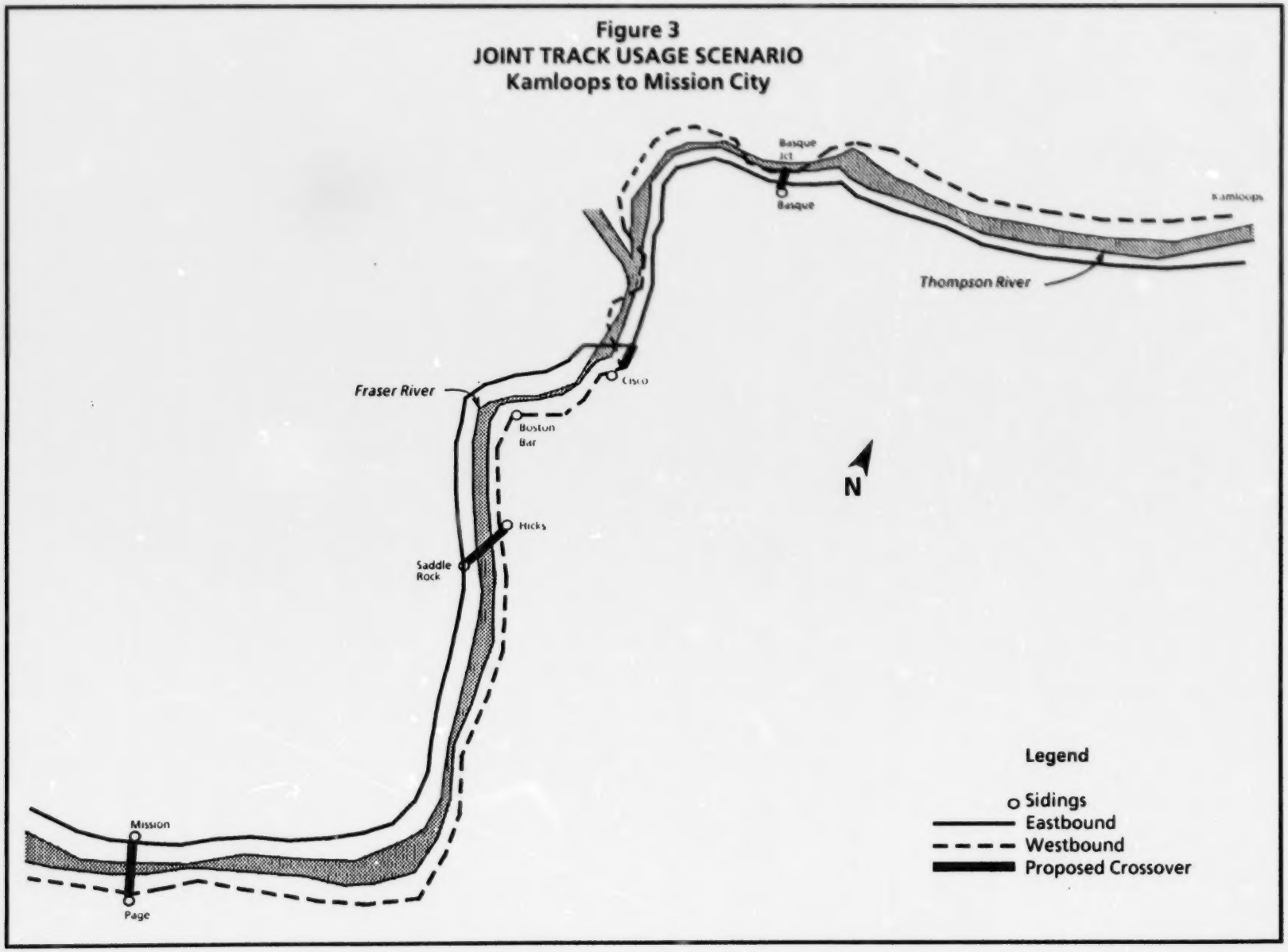


Figure 3
JOINT TRACK USAGE SCENARIO
Kamloops to Mission City
Basque Jct
Basque
Kamloops
Thompson River
Fraser River
Cisco
Boston Bar
Hicks
Saddle Rock
N
Mission
Page
Legend
Sidings
Eastbound
Westbound
Proposed Crossover

TABLE 8

ESTIMATES OF CANADIAN NATIONAL INFRASTRUCTURE UPGRADES
WITH CONTINUED INDEPENDENT OPERATIONS

	UPGRADE	MILEAGE	(MILLION $)
JTU Study Group Recommendations*			
Upgrade All Turnouts			4.0
Ashcroft Subdivision	New Siding	M. 44.0 - 45.5	4.6
	New Siding	M. 61.0 - 62.6	3.0
	Extend Siding	M. 75.2 - 76.7	3.6
	Extend Siding	M. 81.7 - 82.2	1.6
	Extend Siding	M. 83.5 - 84.0	1.8
Yale Subdivision	New Siding	M. 13.4 - 15.0	3.8
	New Siding	M. 30.8 - 32.2	1.6
	New Siding	M. 58.2 - 59.7	2.3
	New Siding	M. 72.4 - 74.1	3.4
Signal relocation and additions			7.9
Total			37.6**
CN Expansion Plans Using JTU Study Cost Estimates**			
Ashcroft Subdivision	Double Track	M. 34.0 - 45.0	16.7
	Double Track	M. 60.0 - 69.0	25.3
	With Tunnel	M. 67.2 - 67.4	
Yale Subdivision	Double Track	M. 0.0 - 4.0	14.1
	With Bridge	M. 1.9 - 2.1	
	Double Track	M. 51.0 - 64.0	
	With Bridge	M. 58.0 - 58.1	
	Bridge	M. 59.0 - 59.1	
	Bridge	M. 59.3 - 31.5	16.7
Signal Additions			4.8
Total			77.6

Total Costs: JTU Proposal: 37.6 Million
CN Double Track: 77.6 Million
With Turnouts: 81.6 Milllion

* Costs and locations with the exception of signals are from Delcan (1985), pp. 12-4

** Costs are from Delcan V.2 (1985), pp. B.1-4, double track locations are from LeClair (1984)

siding extension option would be $37.6 million while limited

double track would cost approximately $77.6 million, (just over twice the siding extension estimate). If limited double track were installed with new medium speed turnouts, costs would rise to approximately $81.6 million.

Table 9 provides the equivalent data for CP. The Joint Track Usage study team recommended the building of 4 additional

TABLE 9

ESTIMATES OF CANADIAN PACIFIC INFRASTRUCTURE UPGRADES
WITH CONTINUED INDEPENDENT OPERATIONS

	UPGRADE	MILEAGE	COST (MILLION $)
JTU Study Group Recommendations*			
Thompson Subdivision	New Siding	M. 20.0 - 21.7	6.8
	Extend Siding	M. 53.3 - 55.3	2.2
	New Siding	M. 89.6 - 91.4	2.0
	New Siding	M. 99.0 -100.6	3.7
Cascade Subdivision	New Siding	M. 10.2 - 11.8	20.4
	With Tunnel	M. 9.8 - 10.4	
	With Tunnel	M. 11.2 - 11.6	
	Extend Siding	M. 16.3 - 17.0	.9
	Signalling		4.7
Total			40.7
Limited Double Track			
Thompson Subdivision	Double Track	M. 24.6 - 39.0	20.9
	Double Track	M. 89.0 -100.9	18.0
	Double Track	M.117.0 -120.4	4.8
Cascade Subdivision	Double Track	M. 0.0 - 7.2	27.4
	With Bridge	M. 5.0 - 5.8	
	Double Track	M. 29.0 - 36.0	10.7
	Signalling		5.7
Total			87.5

Total Costs: JTU Proposal: $40.7 Million
CP Double Track: $87.5 Million

sidings and the extension of two to provide for short segments of

double track operations. A limited double track scheme was developed for CP based upon the CN principals of double tracking portals and breaking long segments of single trackage. In this scheme, five double track segments would be constructed. Two of these would be located at the entrance points to North Bend. The other three would be located approximately at the one third and two third points along the Thompson, and approximately midway along the Cascade. These latter three double track segments were located in areas where construction costs could be minimized.

In total, the costs of new siding and siding extensions are estimated at $40.7 million.[5] The alternative limited double track option would also cost approximately twice this at $87.5 million. The higher costs for CP track improvements are related to the tunneling cost of providing one of the sidings on the Cascade subdivision and the larger amount of double trackage required to implement a comparable limited double track scheme.

3. JOINT TRACK USAGE OPTIONS

In assessing joint track usage, utilizing existing infrastructure, the JTU study suggested that either a large number of interchanges would be required to allow for maintenance and other outages or that a substantial amount of additional double track would be required. Table 10 provides the cost of the JTU schemes illustrated in Figure 3.

An option that was not fully addressed was unidirectional

running of CN and CP traffic, interchanging at Mile 117 of the CP Shuswap Subdivision and Mile 3.5 of the CN Okanagan Subdivision, southeast of Kamloops and at Mission City to the West of the JTU territory. This could be seen as an intermediate solution, providing capacity between the proposals for individual running with limited double tracking and a full complement of crossovers at intervals of 28 miles, suggested by the JTU study team.

Under this option, all trains moving westbound, including heavily loaded bulk commodity trains would use CN track, which is characterizied by less extreme grade and curvature conditions and all trains moving eastbound would utilize CP tracks.

This option would produce problems outside the limits of the original JTU study pertaining to the present inability of CN Kamloops and Boston Bar Yards to handle CP solid train lengths. It would remove the potential problem of insufficient power for CN solid trains to handle CP grades west of Kamloops. It would also require that CN empty traffic moving eastbound travel an additional 3.5 miles west along the Okanagan Subdivision to Kamloops before proceeding along the CN mainline. The capital and operating costs of a crossover track allowing this loop are not provided in the Joint Track Usage Study.

Under this option, it is assumed that sections between crossover points would be closed for maintenance. Existing sidings would remain to allow for single track operations during these periods. A limited number of extended CN sidings would be extended to 7200 feet to handle single track operations during

maintenance and other outage periods, as well an additional and two upgraded crossovers between CN and CP trackage. It is assumed, for the purposes of this analysis, that 12 such extensions would be undertaken, requiring an additional 4.2 miles of track.

Two alternatives are explored here, and are listed in Table 10 and illustrated in Figure 3.

a) Joint track usage is explored with a minimal upgrading of infrastructure. Under this option, the crossover between CN and CP at Mission City is upgraded to allow for smoother flow of traffic and CN sidings, as required are extended.

The estimated cost of this project, excluding additional operating expenses for CN eastbound empty traffic, alterations to yards at Kamloops and Boston Bar and improvements at mile 3.5 at of the Okanagan Subdivision are $25.3 million.

b) The second alternative involves construction or improvement of crossovers at roughly the one third and two thirds points along the proposed joint track usage territory. This would entail the construction of a new crossover between CN and CP at Hicks, near Boston Bar (from CN to CP), and the upgrading of existing crossovers located at Cisco (from CP to CN) and Basque. The crossovers at Hicks and Cisco would allow the fleeting of trains which would be allowed to accumulate at the yards located at Boston Bar and North Bend, if required. For crossovers between CN and CP, intervals would be 57, 71 and 86

miles. For CP to CN crossovers, intervals of 56, 33 and 107 miles would occur.

The estimated cost of this project, excluding additional

TABLE 10
ESTIMATES OF ADDITIONAL INFRASTRUCTURE REQUIRED
UNDER SINGLE DIRECTION JOINT TRACK USAGE*

	UPGRADE	MILEAGE	COST (MILLION $)
No Infrastuructural Change			
Upgrade Crossovers at: Mission City			8.6
Extend 10 CN Siding Lengths to allow for CP empties			9.2
Signalling at Extended CN Sidings:			4.7
Total			23.5
Upgrading Crossovers at:	Basque Jct.		4.1
	Mission City		8.6
New Crossovers	Cisco		10.7
	Hicks		17.5
Signalling			8.1
Extend 10 CN Siding Lengths to allow for CP empties			9.2
Total			58.2
Limited Construction of Crossover			
Full Joint Track 2 Way Usage			
Upgrading Crossovers at:	Basque Jct.		4.1
	Mission City		8.6
New Crossovers	Tranquille		22.5
	Savona		9.7
	Walhachin		4.8
	Spences Bridge		34.2
	Cisco		10.7
	Conrad		22.7
	North Bend		25.3
	Hicks		17.5
	Saddle Rock		19.2
	Ruby Creek		31.8
	Mission City		8.6
Signalling			22.4
Extend CN Siding Lengths to allow for CP empties			9.2
Total			251.3

* Costs and locations with the exception of signals are from (Delcan 1985, V.1, Chapter 6 and pp. 13.8)

operating expenses for CN eastbound empty traffic, alterations to yards at Kamloops and Boston Bar and improvements at mile 3.5 of the Okanagan Subdivision are $58.2 million. It is difficult to assess the full impacts of the joint track usage options without indications of additional, required costs. Additional investment though, would probably not increase capital costs beyond those of the upgrades suggested for independent operation. A third option is shown in Table 10 for illustrative purposes. This is the Joint Track Usage study team proposal which involves the construction of additional crossovers to allow for interchanging of traffic at roughly 28 mile intervals. Because of the high cost of this option, $251.3 million, it is dropped from consideration.

CHAPTER IV
A METHOD FOR ASSESSING THE BENEFITS OF THE OPTIONS

1. CAPACITY AND COST

The two major benefits of increasing infrastructure in this area is the capacity to move more traffic between Vancouver and the rest of the country and the introduction of efficiencies in operations. The approach taken by the JTU study team was to assess one of these, capacity.

The second major benefit of improving the plant in this area is the potential principally translates into the potential to change operating costs. Here a tradeoff occurs in the increased cost of servicing more trackage and the savings accruing from decreasing operating costs. The magnitude of this tradeoff varies with the expansion option chosen and the type and level of traffic expected to move through the region. With increasing congestion increases, the benefits of an additional piece of infrastructure designed to alleviate that congestion also increases to the point where the system again becomes saturated. An emphasis in this report, then is in the development of estimates of the marginal benefits of introducing additional traffic under differing expansion schemes. The following sections provides an indication of the factors which are to taken into account and built up in developing these marginal cost estimates.

2. ESTIMATING DELAY COSTS

When a delay occurs involving a meet or an overtake, there are a number of impacts on the costs of operating other trains.

-In slowing down, stopping and speeding up, diesels must expend fuel and or prone to additional wear and tear. In addition, locomotives are kept out of alternate service.

-Cars are prone to additional wear and tear, and must either be rented for additional periods or are kept out of additional service.

-There are additional communications and traffic control costs

-There are increments in the costs of administering and servicing these elements of railway plant.

Less significant, with additional traffic, additional roadway maintenance is required, which in turn, translates in additional delay costs.

These relationships are summarized below in Table 11. Inherent in each are operating expenses, labour and capital costs. Since no additional traffic is generated by delay, but rather existing traffic spends a larger amount of time on the line, track and roadway maintenance costs, which are most directly related to traffic levels were excluded.

TABLE 11
A SUMMARY OF DELAY COSTS

FIRST ORDER INCREASES IN OPERATING STATISTICS

- Locomotive hours
- Fuel expenditure
- Car utilization
- Train constrol and communication

INDIRECT COST IMPLICATIONS

Locomotives
- Administration
- Repairs
- Servicing
- Capital and Depreciation
- Material Storage Expense
- Municipal and Other Taxes

Freight Cars
- Administration
- Repairs
- Capital and Depreciation
- Material Storage Expense
- Municipal and Other Taxes

Fuel Costs

Fuel Station
- Administration
- Maintenance
- Capital and Depreciation
- Material Storage Expense
- Municipal and Other Taxes

Resultant Shop Machine and Equipment
- Administration
- Maintenance
- Capital and Depreciation
- Material Storage Expense
- Municipal and Other Taxes

Communications
- Train Control
- Administration
- Maintenance
- Capital and Depreciation
- Material Storage Expense
- Municipal and Other Taxes

SECOND ORDER INCREASE IN OPERATING STATISTICS (DUE TO INCREASED MAINTENANCE TIME AND THUS INCREASE TRACK TIME DEDICATED TO COMPANY SERVICE)

Same as First Order Impacts with the addition of:
15 hours of tie replacment
4 hours of rail replacement
4 hours of resurfacing
and an additional day of slow order and congestion due to trains on company service per additional solid train per year
(derived from Hay (1982), Chapter 29))

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Cost were developed following (RTC, 1976) and utilized the 1984 non-confidential system total cost data for CN and CP available in their Annual Reports submitted under Section 331 of the Railway Act (CTC, 1985). This data was supplemented by car leasing costs available in the Registry of Freight Equipment for June, 1984 (AAR, 1965).[6]

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TABLE 12
ESTIMATES OF CN AND CP DELAY COSTS PER TRAIN HOUR

COST PER HOUR	PASS	LOCAL	FAST	SLOW	SOLID
CN WESTBOUND	$843	$515	$701	$547	$377*
EASTBOUND	$843	517	676	644	444
CP WESTBOUND	$843	330	889	791	894
EASTBOUND	$843	580	851	563	596

* Cost for Solid Trains are somewhat low than would be expected for a number of reasons:
-these trains contrain a number of government hoppers for which no cost of capital was assessed
-these trains tended to have low average speeds and since a number of costs in the model used are driven by train miles, these tended to be low
-because of the intensive utilization of new motive power on CN trains, and the high tonnage to horse power ratios achievable, power costs were considerably lower.

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These show an average cost per hour of delay varying from $330. a CP local to $894 for a CP solid. CP costs are estimated to be somewhat higher than CN on a train hour basis primarily because of its longer consists in this area (See Tables 2 and 6 above).

CHAPTER V
ESTIMATING THE OVERALL BENEFITS OF CAPACITY EXPANSION OPTIONS

In this chapter, capacity estimates are developed for the four subdivisions in Joint Track Usage territory under present conditions and under different capacity expansion scenarios. In addition, the relative costs and benefits of these scenarios are estimated under present and a sample of future traffic levels.

Two General types of capacity expansion projects are discussed and assessed:

- -continued single track independent operations with additional sidings or limited stretches of double track
- -joint track usage with limited upgrading of present roadway

1. ESTIMATING CAPACITY AND DELAY

Capacity estimates were developed using the CIGGT line model and the Australian BTE STS simulation model. Since both the STS simulations and the CIGGT analytic model produced very similar results, for the sake of brevity only CIGGT model results are reproduced below.

Generally, present operations were assumed at CP's 1982 level and CN's 1984 levels, since data was readily available for these periods. An exception was the addition of a passenger service inaugurated on the CN line in 1985. In addition, construction completed in 1985 by CN adding 4 miles of double track just west of Kamloops was included as well as the introduction of intermediate signals on both CN and CP lines.

To maximize the effects of congestion, the heaviest trains, generating the greatest delays when stopped were allowed to increase. In Chapter 2, it was shown that most growth is expected in other traffic, so that the results reported will tend to be somewhat conservative. In addition, changes in operational performance due to extending train lengths were not incorporated in this analysis.

The analysis which follows examines each subdivision separately. This is done because:

1) Yards are located at the ends of these subdivisions and therefore, fleeting can be initiated at these points.

2) A delay occurs for most traffic at the ends of each line to allow for inspection and crew changes.

2. SINGLE TRACK SEPARATE OPERATION ALTERNATIVES

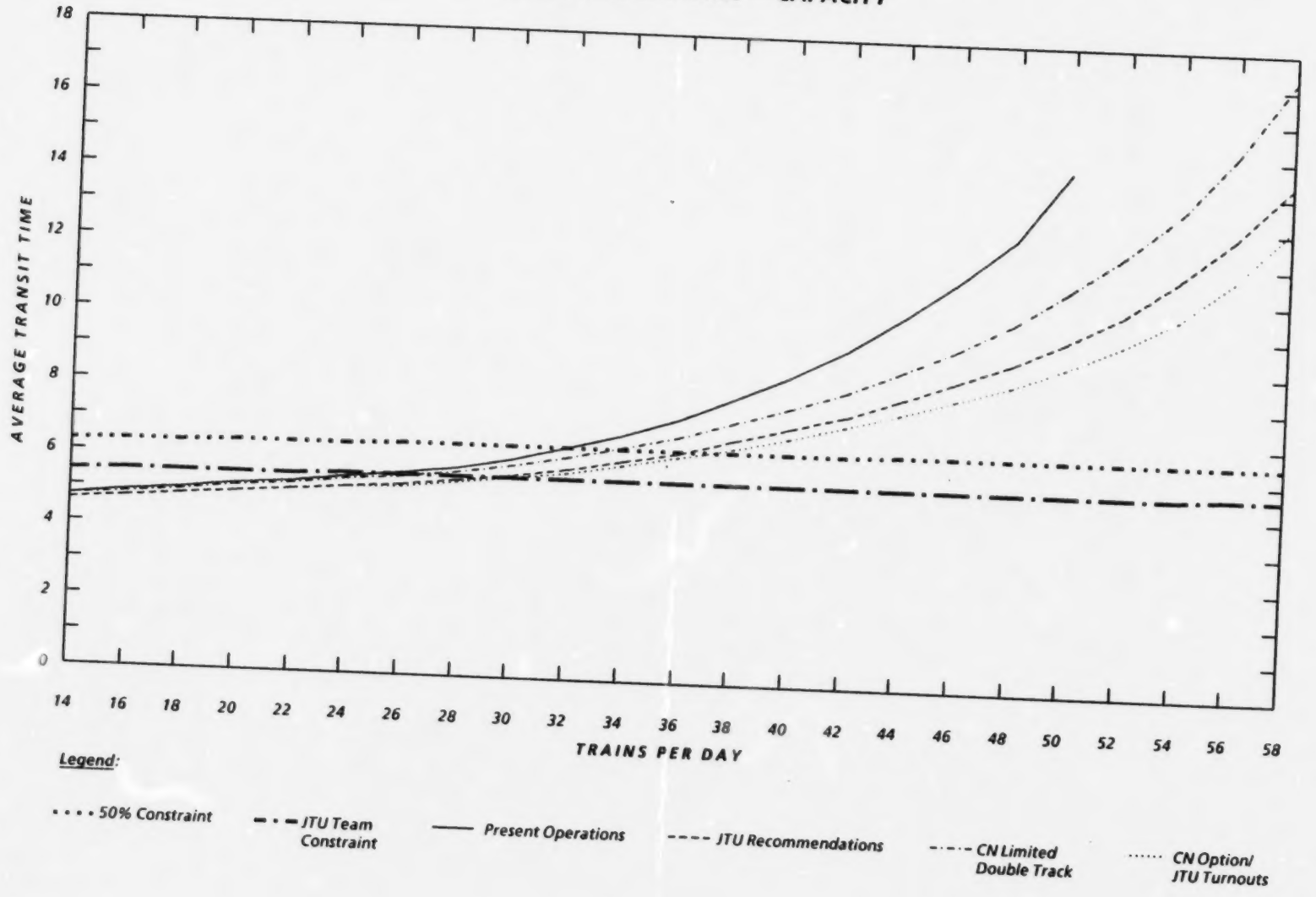
a. The CN Ashcroft Subdivision

Figure 4 provides estimated average transit times for the Ashcroft Subdivison under normal operations. In this figure, the implications of 4 options are presented:

-present operations,
-additional sidings and improved turnouts as recommended by the original JTU study team,
-limited double track and
-limited double track with improved turnouts.

Among the four subdivisions studied, estimated Ashcroft subdivision capacity is lowest. Assuming a maximum allowable transit time of 60 minutes per hundred miles leads to an estimated capacity of 25 trains per day, assuming full capacity over 9 months per year and restricted capacity due to maintenance

Figure 4
ASHCROFT SUBDIVISION — CAPACITY



over three months.[7] Allowing a delay of 50% of free running time, leads to an increase in the capacity estimate for this line to 31 trains per day. Given average traffic densities of 19.3 trains per day on the Ashcroft in 1984, there would seem to be no present capacity problem. A problem may emerge by 1995 if the optimistic projection of 27.6 trains per day becomes a reality, since this lies above the JTU study team capacity limit.

TABLE 13
ASHCROFT SUBDIVISION CAPACITY ESTIMATES
USING THE CIGGT LINE MODEL
WITH SINGLE TRACK, INDEPENDENT OPERATIONS

	JTU Study Team Constraint			50% Constraint			Maximum Net Ton Miles		
	Norm	Main	Mean	Norm	Main	Mean	Norm	Main	Mean*
Present Operations	26	22	25	32	29	31	32	28	31
JTU Recommendations	29	25	28	36	30	35	38	32	37
CN Double Track	27	23	26	34	31	33	36	30	35
CN Double Track and JTU turnout speeds	30	26	29	37	32	36	41	35	40

* Capacity Estimates are provided as follows:
  -under normal operations, assuming a 22 hour operating day,
  -under operations with heavy maintenance, assuming a 16 hour operating day and
  -a weighted mean of the two, assuming 9 months of normal operations and 3 months of operations with heavy maintenance

Table 13 and Figure 4 also show the implications of further investment in the options improving single track operations. As in all the examples to follow, options which involve increasing siding turnout speeds siginificantly increase capacity. This is because meets are particularly common on this route and thus general improvements in delay times have much greater impacts

than improvements at specific locations. Either the option suggested by the JTU study team or the CN expansion with this addition provide sufficient capacity to sustain the optimistic traffic projection level estimated for 1995. With siding extensions, capacity would rise to between 28-35 trains per day, with limited double track to 29-36 trains. The double track option provides a greater margin and has the potential to produce greater operational savings.

The implications of these options in terms of increasing productivity and in generating operating savings on the Ashcroft are summarized in Figures 5 and 6. Figure 5 shows that under present traffic loads of 19.3 trains per day, there is a 11% increase in the average revenue tonnage that can be moved through this trackage in a given, restricted time period, under normal operations with the addition of either siding extensions or double track. The difference in the two at this traffic level is marginal. This increases to just over 16% during maintenance periods.

Increasing traffic to 27.6 trains per day, widens this gap to approximately 22% with limited segments of double track and 15% with extended sidings. The limited double track option, with upgraded turnouts provides significant advantages beginning at this traffic level over the option of extending sidings.

Figure 6 provides estimates of costs savings over present operations generated by each investment under differing traffic levels. As with revenue tonnage productivity, this varies

Figure 5
ASHCROFT SUBDIVISION — PRODUCTIVITY

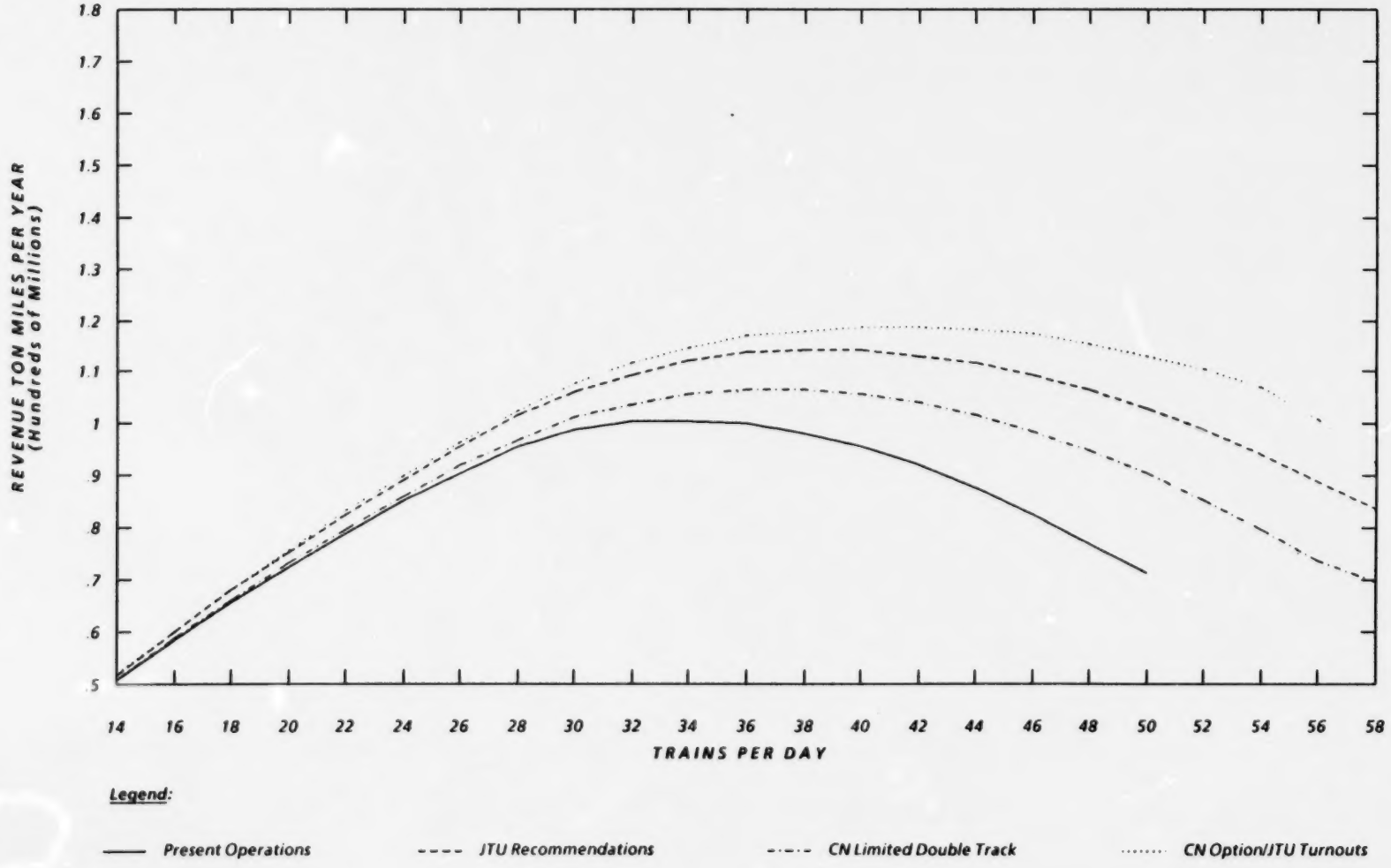
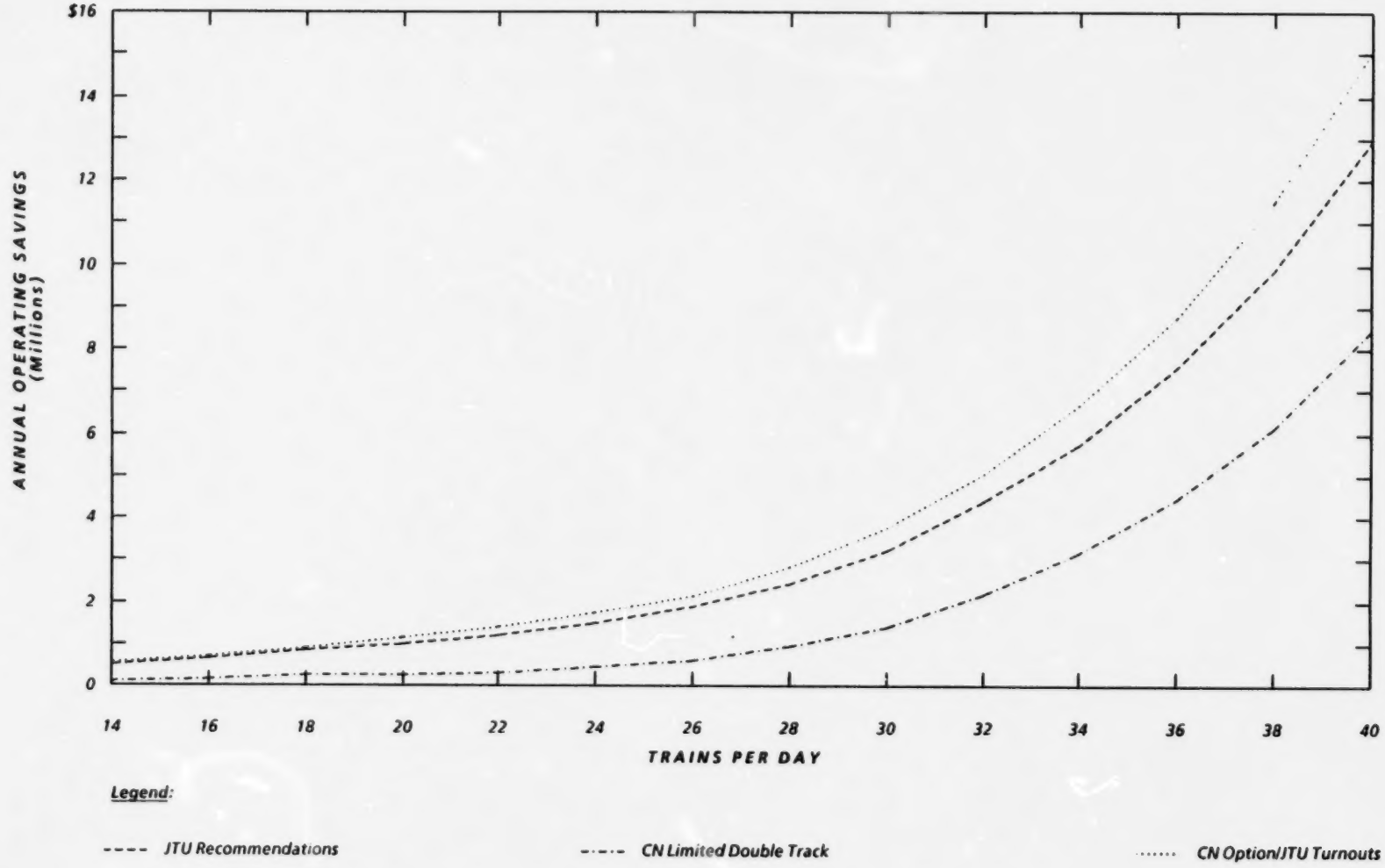


Figure 6

ASHCROFT SUBDIVISION — OPERATING SAVINGS



considerably with traffic levels. Table 14 provides expected savings assuming 1984 traffic levels and the projections for 1989 and 1994 generated in table 4. It indicates that the relative low cost of the joint track usage recommendations make this option particularly attractive. While the CN with higher turnout speeds provides extra capacity and higher operating savings, at projected traffic levels, the benefits, even given optimistic projections, are marginal, given the cost.

TABLE 14
ASHCROFT SUBDIVISION PROJECT COSTS, ESTIMATED SAVINGS
AND ESTIMATED ANNUAL RETURN ON INVESTMENT OPERATING SAVINGS
WITH SINGLE TRACK, INDEPENDENT OPERATIONS*

	PROJECT COST (Millions)	TRAFFIC LEVEL (TRAINS/DAY)	OPERATING SAVINGS (Millions)	% RETURN
JTU OPTION	20.6			
1985 Traffic Levels		19.4	1.0	4.9%
1990 Pessimistic		22.2	1.3	6.3
Optimistic		24.0	1.6	7.7
1995 Pessimistic		24.6	1.7	7.8
Optimistic		27.6	2.4	11.6
CN DOUBLE TRACK	44.4			
1985 Traffic Levels		19.4	.3	.7
1990 Pessimistic		22.2	.4	.9
Optimistic		24.0	.5	1.1
1995 Pessimistic		24.6	.5	1.1
Optimistic		27.6	.9	2.0
CN DT WITH TURNOUTS	46.4			
1985 Traffic Levels		19.4	1.2	2.8
1990 Pessimistic		22.2	1.6	3.5
Optimistic		24.0	1.9	4.1
1995 Pessimistic		24.6	2.0	4.3
Optimistic		27.6	2.8	6.0

* All reported figures are in 1984 constant dollars.

b. The CN Yale Subdivision

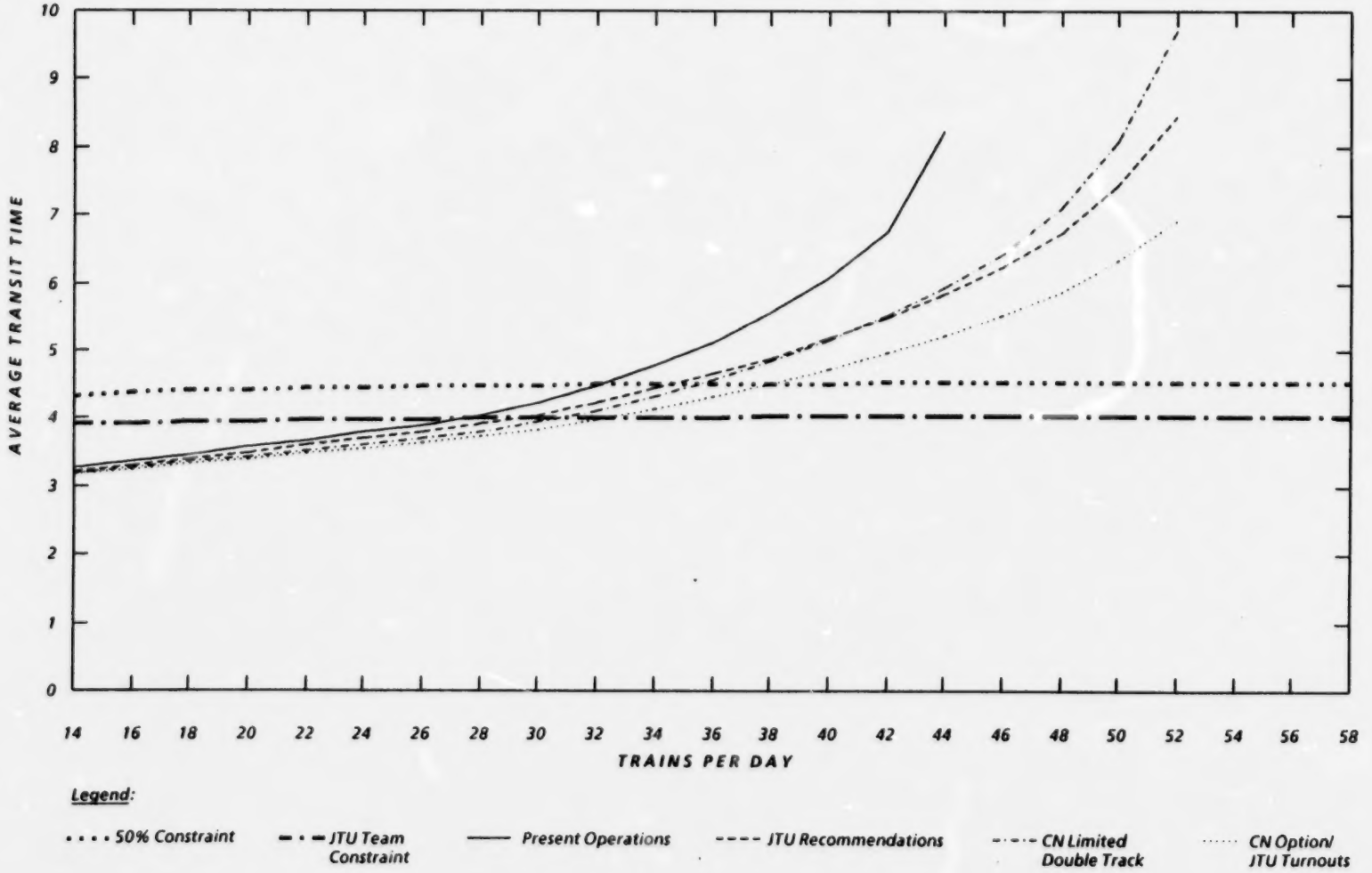
Figure 7 provides transit time and capacity estimates for the Yale Subdivision. It is clear that the Ashcroft, rather than the Yale, provides the major bottleneck in this portion of the CN system. As Table 15 shows, the very restrictive assumptions used in the JTU study provided a capacity estimate of 27 trains per day trains with maintenance periods included. The less restrictive assumption of allowing a delay of 50% of operating time, increases the capacity estimate to 31 trains per day. Adopting optimistic growth projections, traffic levels fall in this range by 1995. Under this most restrictive capacity constraint and optimistic growth, there are potential capacity problems at 1995 traffic levels.

TABLE 15
YALE SUBDIVISION CAPACITY ESTIMATES
USING THE CIGGT LINE MODEL

	JTU Constraint			50% Constraint			Maximum Net Ton Miles		
	Norm	Main	Mean	Norm	Main	Mean	Norm	Main	Mean*
Present Operations	28	24	27	32	26	31	34	28	33
JTU Recommendations	31	25	30	35	29	34	40	34	39
CN Double Track	30	24	29	35	29	34	38	32	37
CN Double Track and JTU turnout speeds	32	26	31	38	32	37	42	36	41

* Capacity Estimates are provided as follows:
-under normal operations, assuming a 22 hour operating day,
-under operations with heavy maintenance, assuming a 16 hour operating day and
-a weighted mean of the two, assuming 9 months of normal operations and 3 months of operations with heavy maintenance

Figure 7
YALE SUBDIVISION — CAPACITY



All three of the capacity expansion options discussed produce sufficient capacity to handle this level of traffic. Figure 8 indicates that under traffic levels of between 25 and 42 trains per day, the building of limited segments of double track, particularly with improved turnouts has a particularly significant impact in improving performance on the line. The JTU study team recommendations tend to provide an intermediate solution.

Figure 9 indicates the relative savings of the three options. In Table 16, this is contrasted with the costs, and annual returns on investment dollars are provided. It is again clear that the limited double track option provides the greatest boost in operating performance on the line. The JTU study team recommendation, at projected traffic levels though, because of their more moderate costs, provide considerably higher rates of return.

As with the Ashcroft subdivision, the relative cost of the JTU study team proposals in conjunction with its ability to satisfy short term capacity problems makes it the most attractive single track options.

Most significant in these findings is that with present projections of traffic loads, there is no dramatic capacity problem associated with continued single track operations. Large scale capital improvement programs along this segment of track do not seem warranted either on cost or capacity grounds. Under continued separate operation, there is a need to explore low cost

Figure 8
YALE SUBDIVISION — PRODUCTIVITY

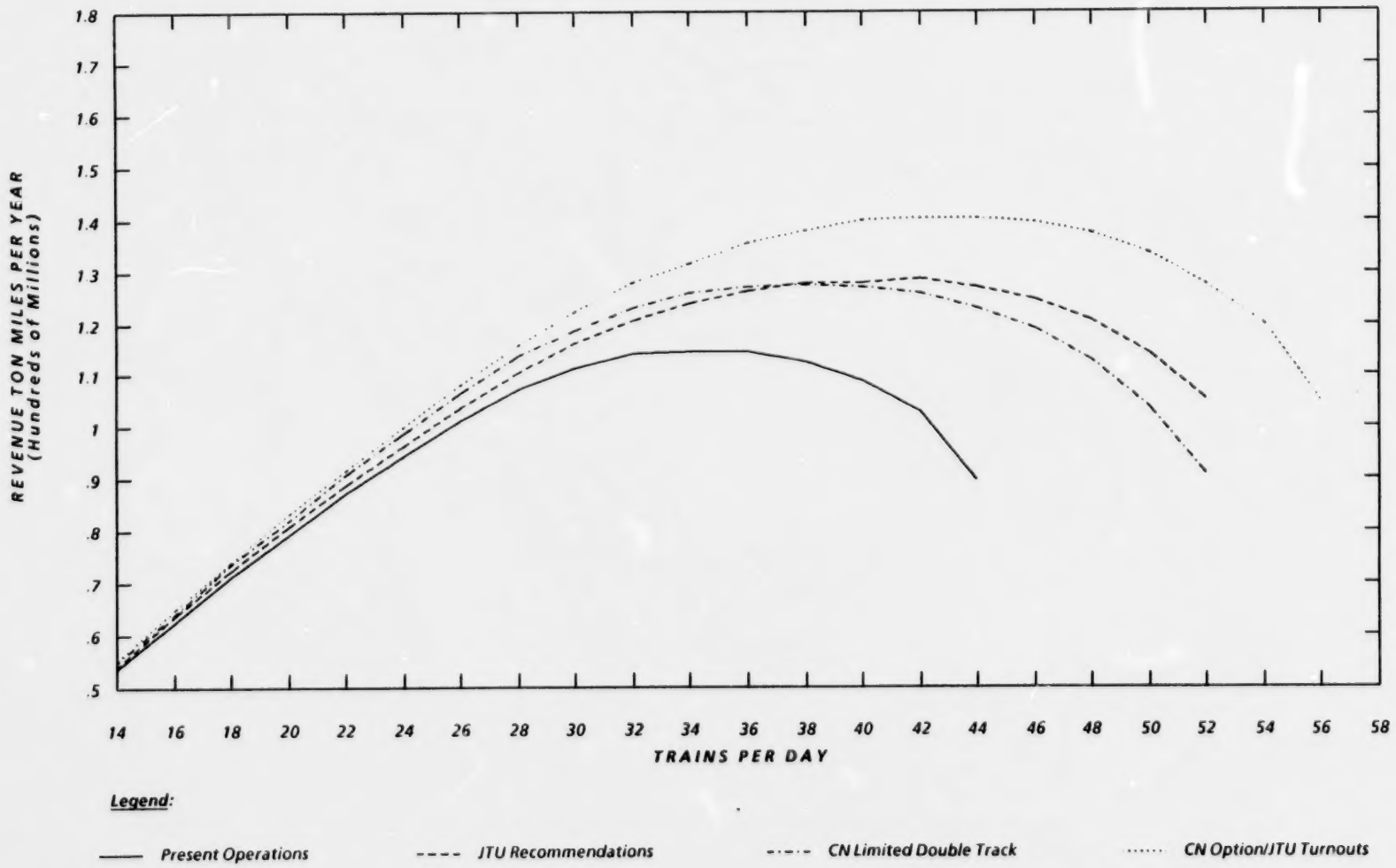


Figure 9
YALE SUBDIVISION — OPERATING SAVINGS

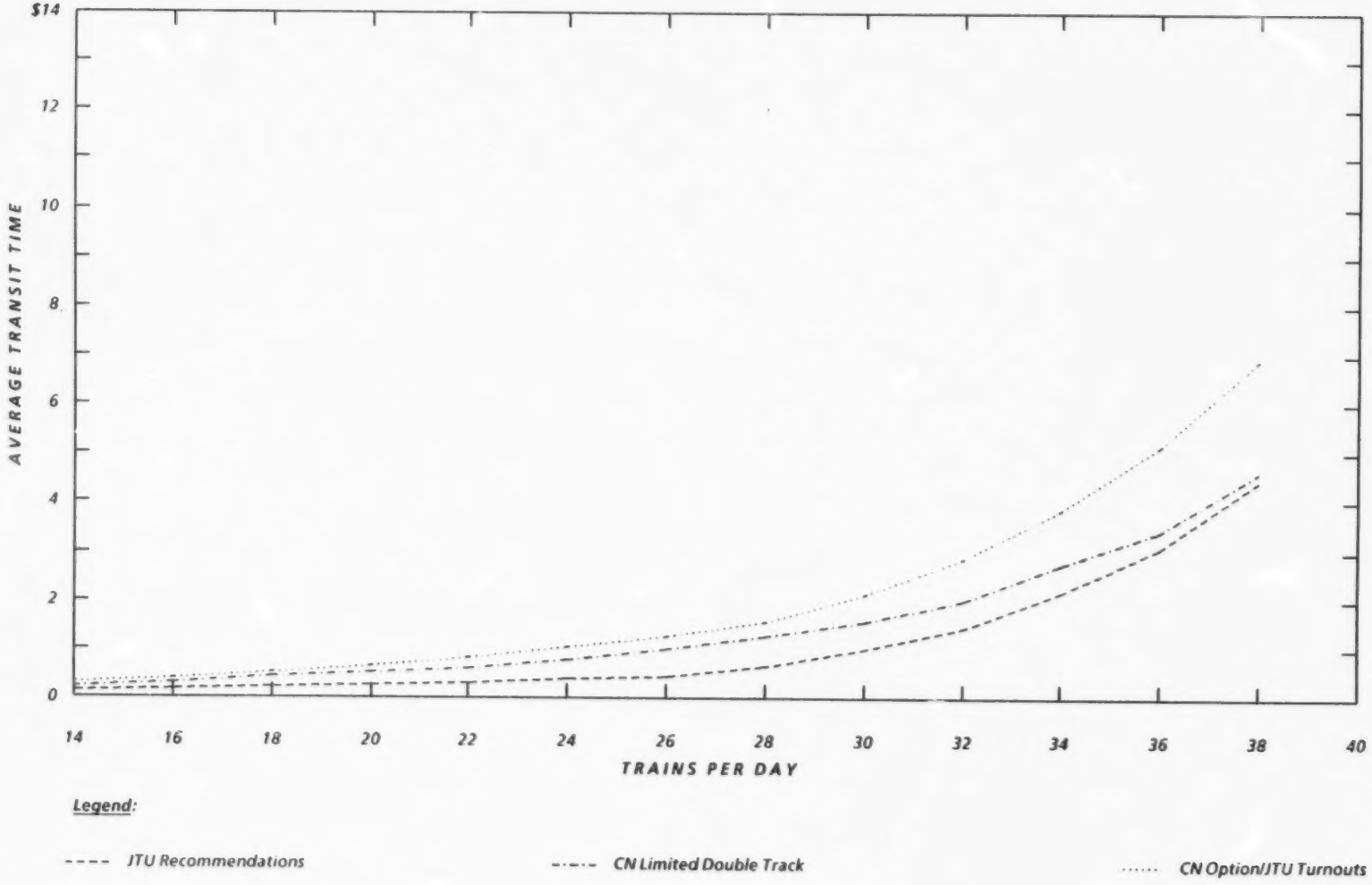


TABLE 16
YALE SUBDIVISION PROJECT COSTS, ESTIMATED SAVINGS
AND ESTIMATED ANNUAL RETURN ON INVESTMENT OPERATING SAVINGS*

	PROJECT COST (Millions)	TRAFFIC LEVEL (TRAINS/DAY)	OPERATING SAVINGS (Millions)	% RETURN
JTU OPTION	17.0			
1985 Traffic Levels		19.8	.5	2.9%
1990 Pessimistic		22.6	.7	4.1
Optimistic		24.4	.8	4.7
1995 Pessimistic		25.0	.9	5.3
Optimistic		28.0	1.3	7.7
CN DOUBLE TRACK	33.2			
1985 Traffic Levels		19.8	.3	.9
1990 Pessimistic		22.6	.3	.9
Optimistic		24.4	.4	1.2
1995 Pessimistic		25.0	.4	1.2
Optimistic		28.0	.7	2.1
CN DT WITH TURNOUTS	35.2			
1985 Traffic Levels		19.8	.7	2.0
1990 Pessimistic		22.6	.9	2.6
Optimistic		24.4	1.1	3.1
1995 Pessimistic		25.0	1.2	3.4
Optimistic		28.0	1.7	4.8

* All reported figures are in 1984 constant dollars.

options which provided incremental improvements in capacity. Good examples of this, include the introduction of mechanisms which would allow the greater fine tuning of meets in this area or the introduction of motive power, more efficient cars and/or possibly longer sidings, increasing the revenue ton productivity of CN trains.

c. The CP Thompson Subdivision

The CP lines in the area have higher capacities than CN lines in this area. In addition, though, there is a heavier traffic load, and with the shift in CN traffic to Prince Rupert, there is a greater growth potential here.

The Thompson subdivision has, under present operating practices and conditions, substantially more capacity. Capacity estimates vary from an average of 33 trains per day under the restrictive JTU assumptions to an average of 38 assuming a cumulative delay of 50% of free running time. Productivity on the Thompson is maximized, from Table 17 at 37 trains per day.

Because of longer train lengths and the dedication of large numbers of motive power units to trains, CP has the capacity to move roughly a third more revenue ton miles per year over this track, under present operations. This advantage is, to a degree, incidental, since it is born out of a requirement for motive power and tonnage combinations needed to maximize productivity to the east of this area, at the Rogers Pass.

CP, in conjunction with longer siding lengths, has built higher number turnouts, allowing trains to move more quickly on to sidings during meet situations. Thus, there are only two options for expansion of CP lines, the JTU study team recommendations, and the potential for additional double track.

Under optimistic growth projections, under present operations, traffic per day could increase to 37.2 trains, beyond the JTU constraint. With the expected change in train

lengths, this is reduced to 36.8 trains per day. Under this circumstance, capacity would be taxed in this area, given the estimates in Table 17. Figures 11 and 12 shows that the implications of either investment operations at these traffic levels, is relatively large. In addition, both produce a capacity cushion, allowing the possibility of operating the line beyond this level. In particular the limited double tracking option provides a considerable capacity cushion.

TABLE 17
THOMPSON SUBDIVISION CAPACITY ESTIMATES
USING THE CIGGT LINE MODEL

	JTU Constraint			50% Constraint			Maximum Net Ton Miles		
	Norm	Main	Mean	Norm	Main	Mean	Norm	Main	Mean*
Present Operations	34	28	33	38	34	37	38	34	37
JTU Recommendations	36	30	34	42	36	41	44	40	43
Limited Double Track	38	33	37	46	31	45	48	42	47

* Capacity Estimates are provided as follows:
-under normal operations, assuming a 22 hour operating day,
-under operations with heavy maintenance, assuming a 16 hour operating day and
-a weighted mean of the two, assuming 9 months of normal operations and 3 months of operations with heavy maintenance

Figure 11 shows that the differences in revenue ton mile productivity at projected traffic levels is minor. Gains in productivity begin to become significant at the optimistic projection of 1995 traffic, and are considerable at higher traffic levels. Both of these options would seem to make economic sense beginning at these traffic levels, and are very

Figure 10

THOMPSON SUBDIVISION — CAPACITY

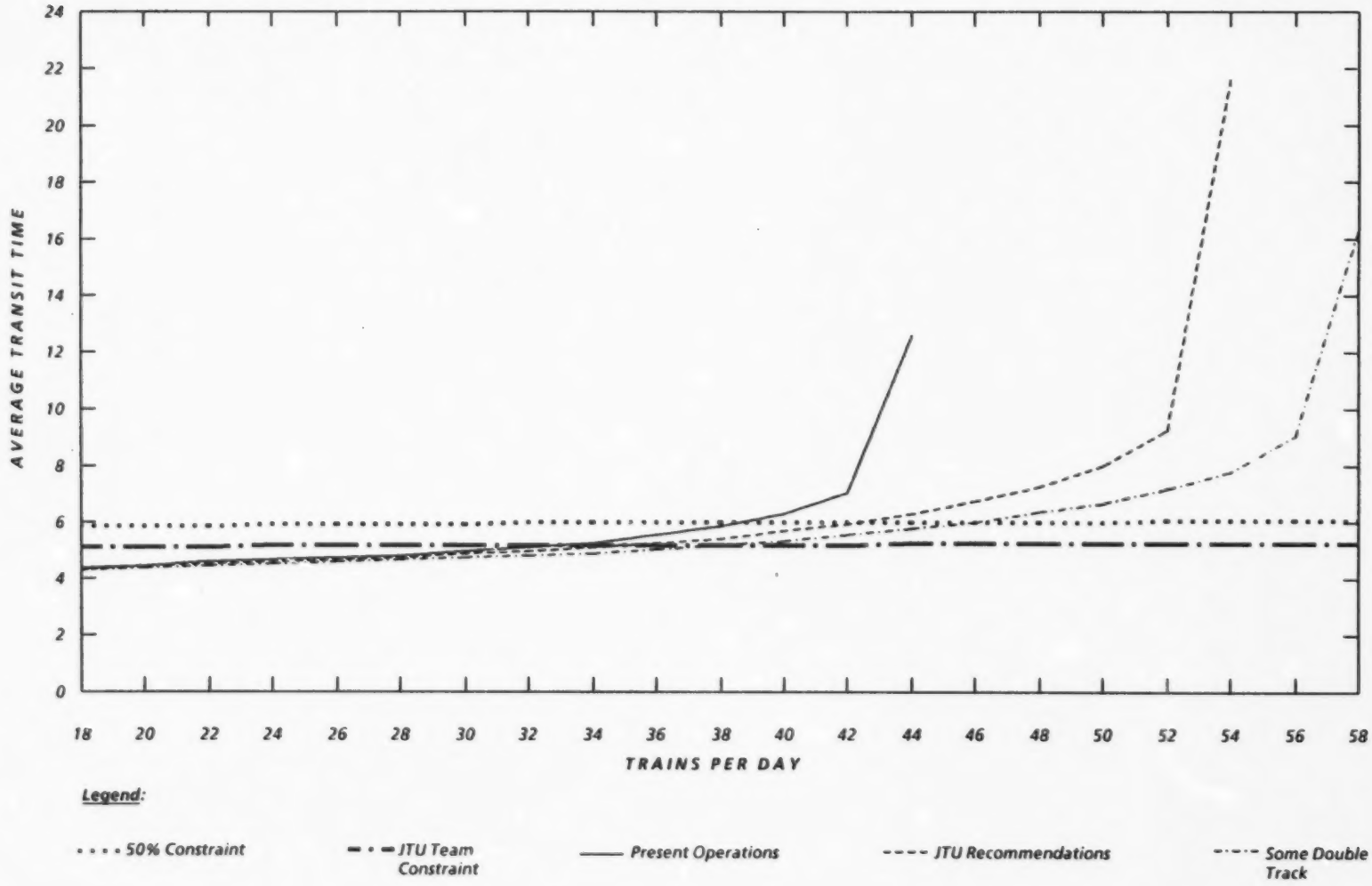


Figure 11

THOMPSON SUBDIVISION — PRODUCTIVITY

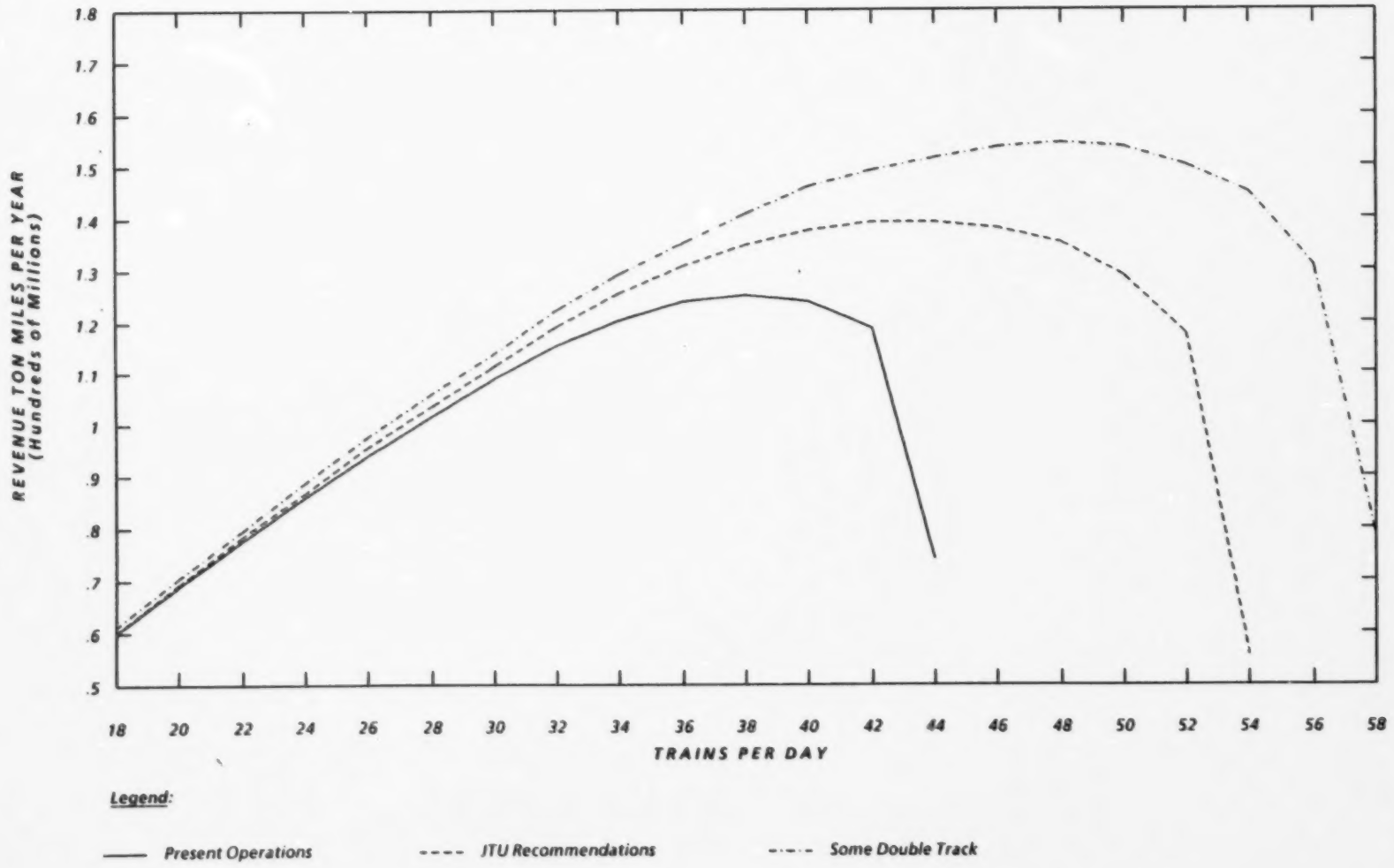
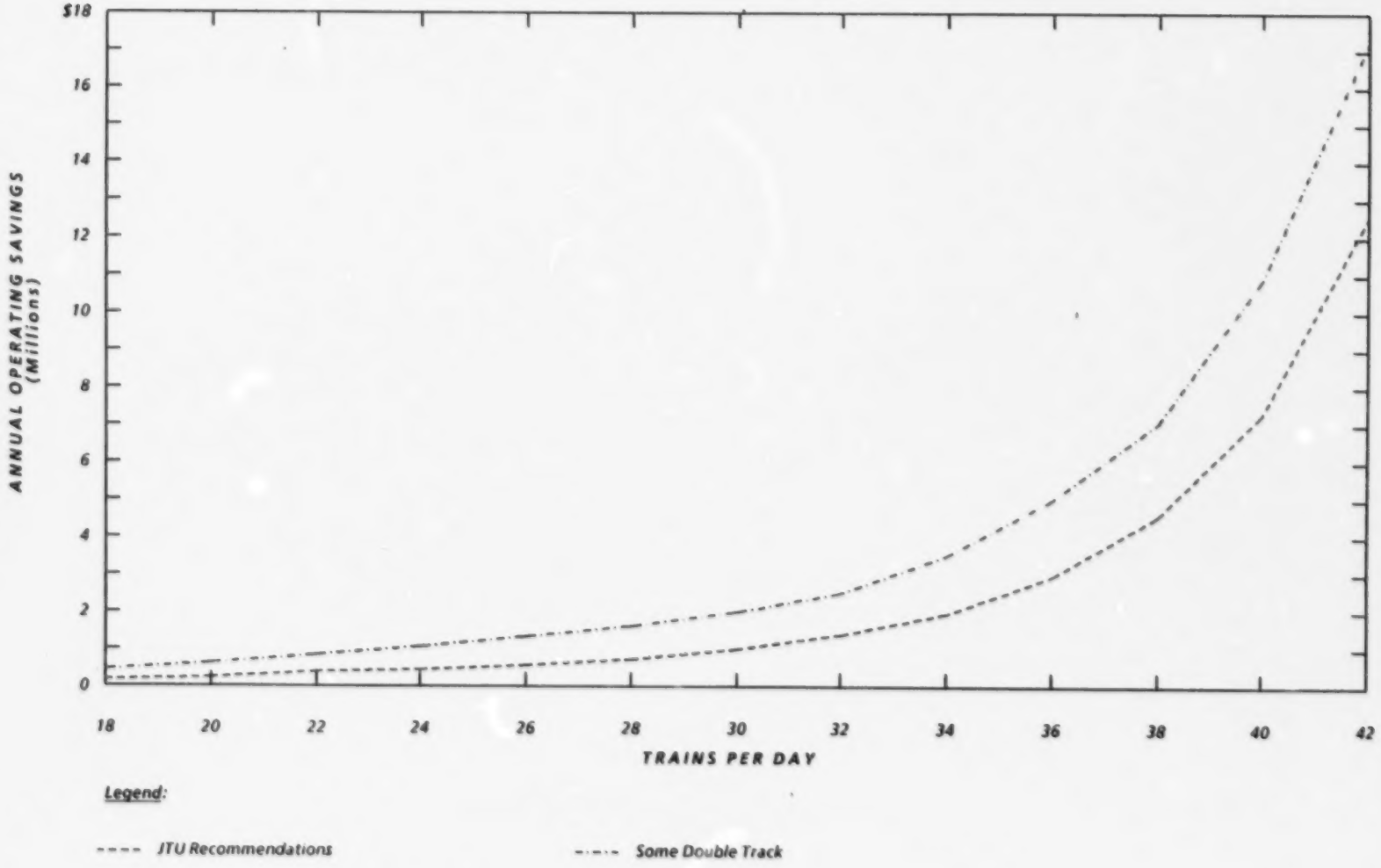


Figure 12
THOMPSON SUBDIVISION — OPERATING SAVINGS



attractive beyond this level.

While some double track would increase throughput at very high traffic levels and provide some additional traffic, these become investment alternatives within the next decade. Given the

TABLE 18
THOMPSON SUBDIVISION PROJECT COSTS, ESTIMATED SAVINGS AND ESTIMATED ANNUAL RETURN ON INVESTMENT OPERATING SAVINGS*

	PROJECT COST (Millions)	TRAFFIC LEVEL (TRAINS/DAY)	OPERATING SAVINGS (Millions)	% RETURN
JTU OPTION	17.1			
1985 Traffic Levels		25.2	.5	2.9%
1990 Pessimistic		27.4	.6	3.5
Optimistic		29.6	1.0	5.9
1995 Pessimistic		31.4	1.3	7.6
Optimistic		36.8	3.8	22.2
LIMITED DOUBLE TRACK	46.6			
1985 Traffic Levels		25.2	1.1	2.3
1990 Pessimistic		27.4	1.4	3.0
Optimistic		29.6	1.8	3.9
1995 Pessimistic		31.4	2.3	4.9
Optimistic		36.8	5.9	12.7

* All reported figures are in 1984 constant dollars.

relatively low cost of the JTU study team proposal, this option is particularly attractive. Additional, short segments of double track, though, provide more of a capacity cushion, and although these are considerably more expensive, they may allow considerable additional expansion.

c. The CP Cascade Subdivision

As on the CN system, the link west of Kamloops provides the system bottleneck. Because of the high proportion of double

Figure 13
CASCADE SUBDIVISION — CAPACITY

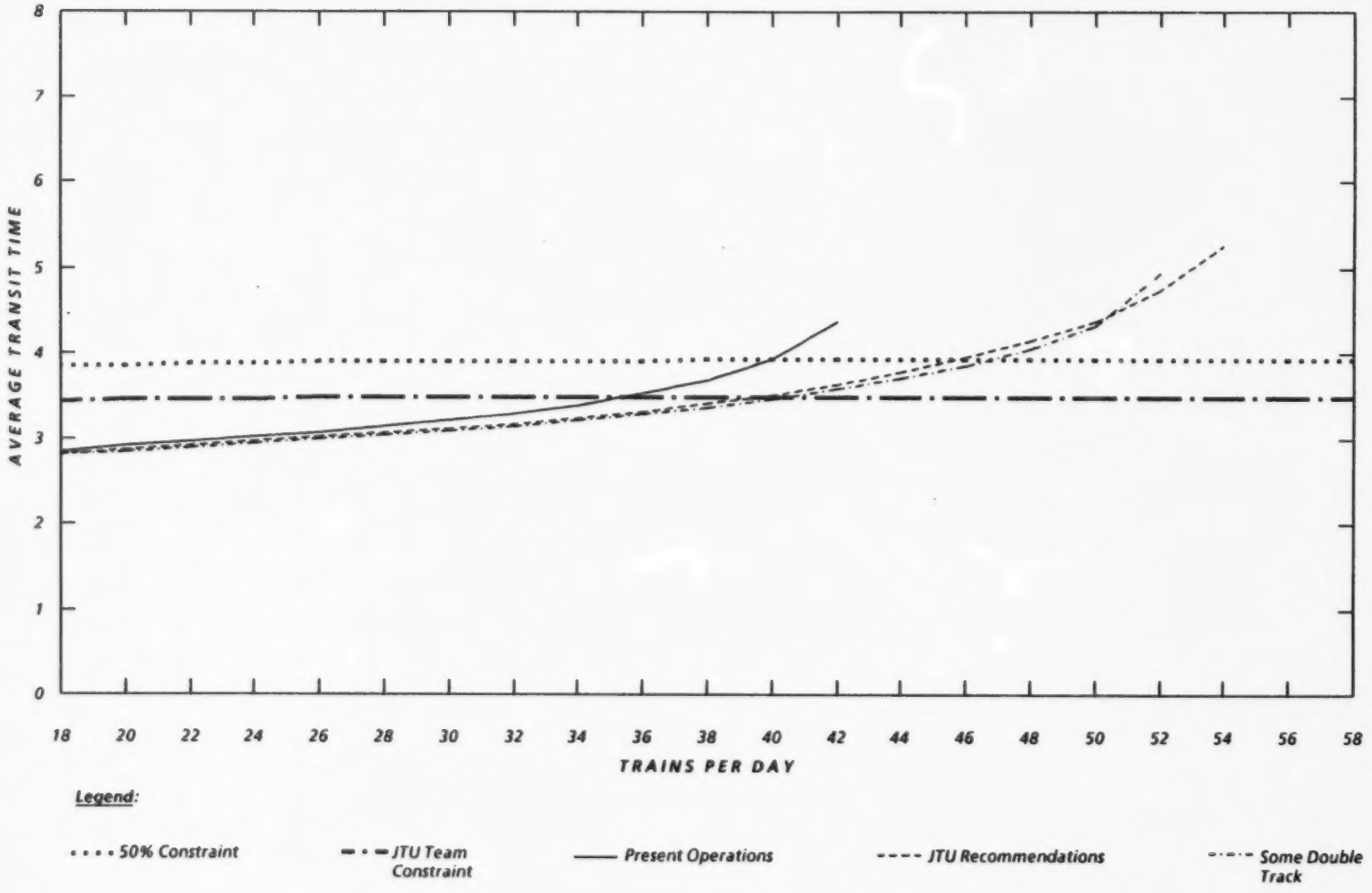


Figure 14
CASCADE SUBDIVISION — PRODUCTIVITY

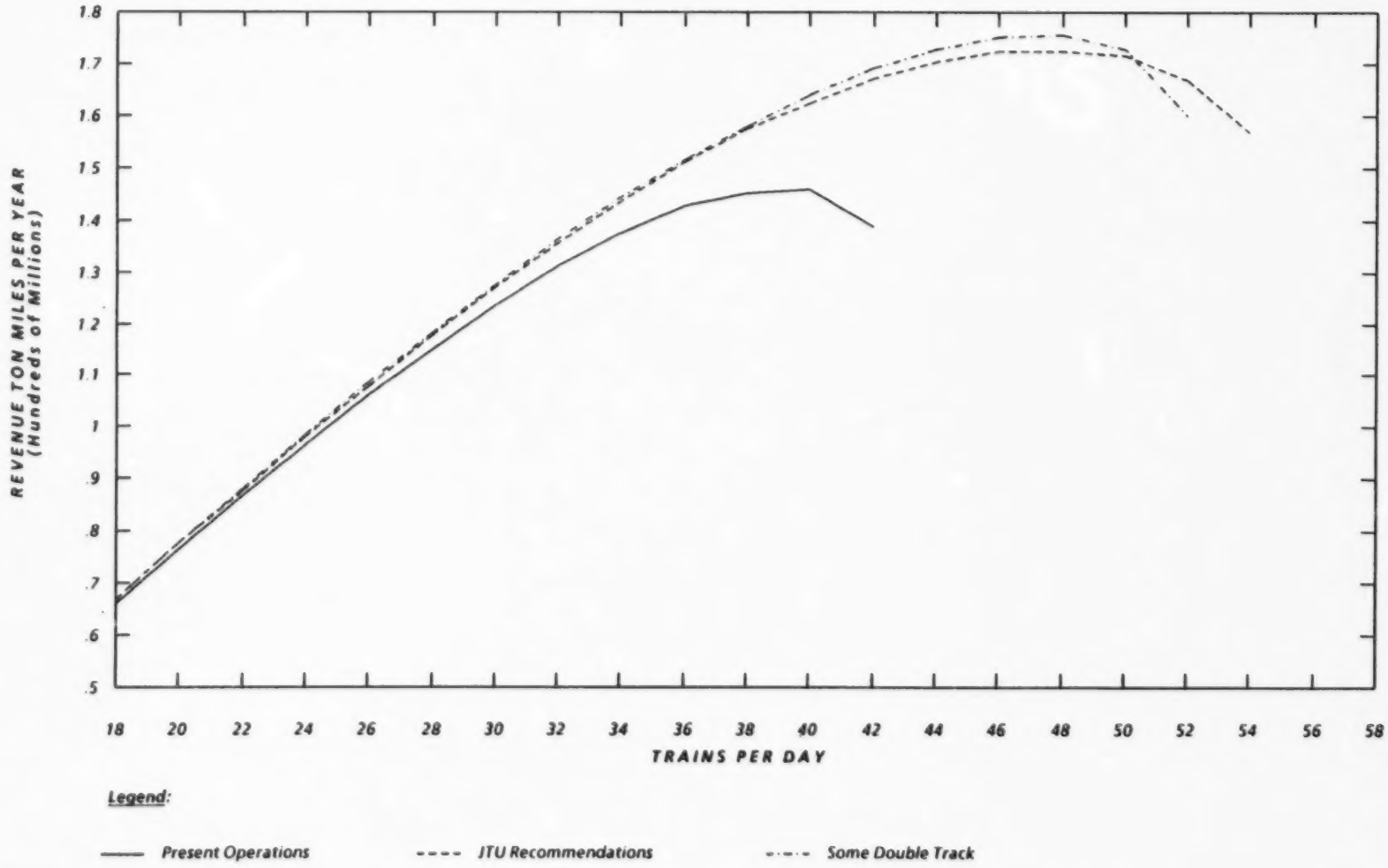
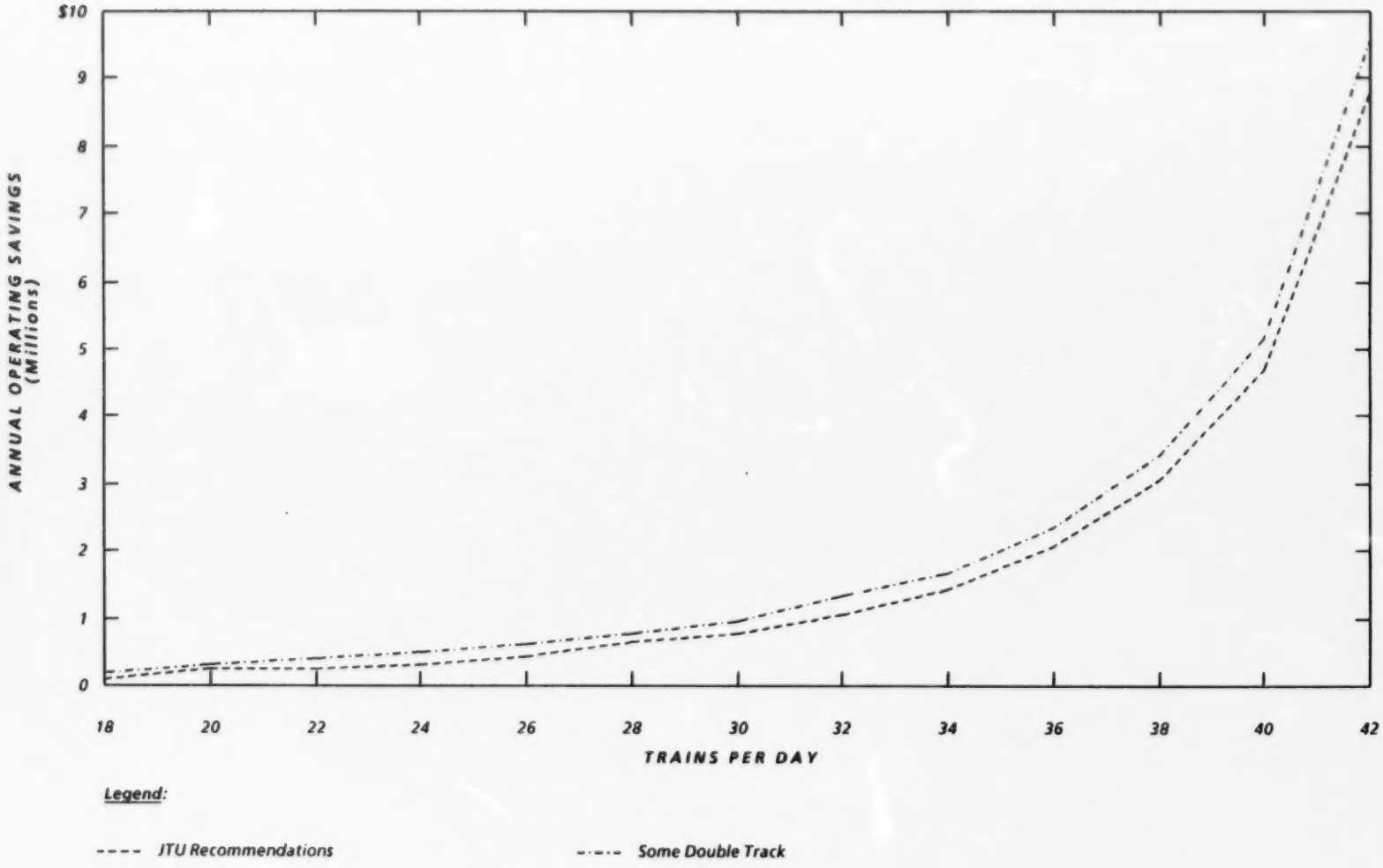


Figure 15

CASCADE SUBDIVISION — OPERATING SAVINGS



track on this link and the few bottleneck sections, capacity estimates are higher. Table 19 and Figure 13 indicate capacities at a traffic level of approximately 35 trains per day, 2 above the Cascade estimate. Additional traffic at this level, considerably increases average delay, although the 50% delay criteria is not met until a traffic load of 40 trains per day.

TABLE 19
CASCADE SUBDIVISION CAPACITY ESTIMATES
USING THE CIGGT LINE MODEL

	JTU Constraint			50% Constraint			Maximum Net Ton Miles		
	Norm	Main	Mean	Norm	Main	Mean	Norm	Main	Mean*
Present Operations	36	30	35	40	34	39	39	33	38
JTU Recommendations	40	34	39	46	42	45	47	41	46
Limited Double Track	41	35	40	47	41	46	48	42	47

* Capacity Estimates are provided as follows:
-under normal operations, assuming a 22 hour operating day,
-under operations with heavy maintenance, assuming a 16 hour operating day and
-a weighted mean of the two, assuming 9 months of normal operations and 3 months of operations with heavy maintenance

Both the siding extension and the limited double track options considerably increase capacity along this line, well beyond the capacity of the adjacent bottleneck.

Given optimistic traffic projections, a marginal case can be made to meet growth in traffic by 1995. These is some case to be made for expansion in the 1990's with expansion in traffic, given the returns estimated in Table 20. The option provided by the JTU study team provides considerably additional capacity without the additional costs of the limited double track option.

TABLE 20
CASCADE SUBDIVISION PROJECT COSTS, ESTIMATED SAVINGS
AND ESTIMATED ANNUAL RETURN ON INVESTMENT OPERATING SAVINGS*

	PROJECT COST (Millions)	TRAFFIC LEVEL (TRAINS/DAY)	OPERATING SAVINGS (Millions)	% RETURN
JTU OPTION	23.6			
1985 Traffic Levels		25.2	.4	1.7%
1990 Pessimistic		27.4	.6	2.5
Optimistic		29.6	.7	3.0
1995 Pessimistic		31.4	1.0	4.2
Optimistic		36.8	2.4	10.2
LIMITED DOUBLE TRACK	41.4			
1985 Traffic Levels		25.2	.5	1.2
1990 Pessimistic		27.4	.7	1.7
Optimistic		29.6	.9	2.2
1995 Pessimistic		31.4	1.2	2.9
Optimistic		36.8	2.8	6.8

* All reported figures are in 1984 constant dollars.

3. JOINT TRACK USAGE OPTIONS

Two joint track use options are explored in this following. In the first scenario, it is assumed that all westbound loaded traffic is diverted to CN track with the exception of local traffic and all CN eastbound traffic is moved to CP tracks. For maintenance purposes, it is assumed that each side is shut down for 1.5 months per year and all traffic is routed along the remaining track. In the second scenario, it is assumed that crossovers are improved at Basque and built between Boston Bar and North Bend and that approximately one third of trackage on either side is unavailable for double track operation during one third of the year.

Capacity with joint track usage is set by the Joint Track Usage team as 80 trains per day where both tracks are fully utilized over a 22 hour day. Under the scenario where no usable crossovers exist and single track operations occur for three months of the year, capacity is affected by the bottleneck points for CN and CP at these times. With no improvments to CN or CP lines for the purposes of improved single track operations, it is assumed that capacity is equally effected by both. Under this scenario, therefore average capacity slips to 68 trains. With the addition of crossover, only one third of the system is assumed to be affected by maintenance at any given time. Assuming that maintenance occurs requiring line closing for roughly 25% of the year, capacity is reduced by only 8%, and is weight by the capacity of each single track segment. Under this assumption, capacity rises to 76 trains per day. Under optimistic traffic projects for 1995 (See Tables 4 and 7), traffic would reach 65.2 trains per day, well within the capacity these constraints.

Table 21 indicates the present savings under each scenario in terms of operating expenses under operating levels which approximate current conditions in the the Joint Track Usage Territory.

Moving all westbound loaded traffic to the CN side would create considerable savings to CN by significantly reducing operating time. Because the route is slightly longer, additional

operating time is incurred by CP westbound traffic along the CN trackage. During periods when maintenance is required along the CP Thompson, and all traffic is diverted to the Ashcroft, this is compounded by considerable increases in congestion. Empty returns, because of their lower priority enjoy considerably smoother running by being totally allocated to the CP Thompson. This advantage, leads to a considerable positive benefit in Joint track usage, even under a situation where no additional crossovers are built. These benefits, though, are disproportionately allocated to CN. With no additional sidings, CP operations become slightly more expensive. The net benefit, under present levels of traffic is approximately $3.6 million, with a loss of .23 million to CP.

In order to sustain this operation, additional motive power would have to be added to CN westbound trains during periods when CN track was unavailable, and some sidings would have to be extended on present CN operations. Given the construction costs, provided in Table 10, totalling $23.5 million with this option, under present traffic loads, a benefit of 16.9% annually would accrue under present traffic levels.

With the addition of usable crossovers, it is assumed that maintenance can be channelled to segments which approximate one third of the present operating distance between Kamloops and Mission/Hydro turnoffs, thus reducing the period that single track operation is required. Under this scenario, single

TABLE 21
ASHCROFT AND THOMPSON JOINT TRACK USAGE
UNDER APPROXIMATED PRESENT OPERATING LEVELS*

ASHCROFT AND THOMPSON JOINT TRACK USAGE
ASHCROFT WESTBOUND

	PRESENT RUNNING		ONE WAY OPERATIONS			DELAY	YEARLY SAVINGS (IN MILLIONS)	
CN	NORM	MAINT	NORM	MAINT	DAILY TRAF	SAVINGS /HOUR	PRESENT TRACKAGE	ADDED CROSSOVERS
PASSENGER	3.90	3.92	3.75	4.17	1.0	$843	.03	.02
LOCAL	5.05	5.25	4.08	7.03	.0	$515	.00	.02
FAST FREIGHT	4.73	4.83	4.20	5.70	1.8	$701	.15	.22
SLOW FREIGHT	5.28	5.78	4.38	7.98	3.8	$547	.34	.63
SOLID/UNIT	5.55	5.48	4.48	7.40	3.1	$377	.19	.37
CP								
PASSENGER	3.65	3.68	3.75	3.75	1.0	$843	-.04	-.03
FAST FREIGHT	4.23	4.33	4.20	4.58	3.4	$889	-.20	-.02
SLOW FREIGHT	4.72	4.92	4.38	5.35	3.4	$791	-.18	.19
SOLID/UNIT	5.08	5.38	4.48	6.35	3.2	$894	.08	.50
						TOTAL:	.37	1.90

THOMPSON EASTBOUND

CN								
PASSENGER	4.05	4.10	3.52	4.17	1.0	$843	.05	.13
FAST FREIGHT	4.92	5.05	3.80	5.70	1.8	$676	.35	.46
SLOW FREIGHT	5.15	5.35	3.92	7.98	3.8	$644	.55	.95
SOLID/UNIT	5.45	5.70	4.00	7.40	3.1	$444	.38	.64
CP								
PASSENGER	3.68	3.73	3.52	5.83	1.0	$843	-.06	.02
LOCAL	4.43	4.63	3.68	5.15	0.2	$580	.02	.04
FAST FREIGHT	4.37	4.52	3.80	4.87	1.8	$851	.13	.27
SLOW FREIGHT	4.58	4.77	3.92	5.20	5.3	$563	.05	.54
SOLID/UNIT	5.07	5.43	4.00	6.65	3.7	$596	.32	.73
						TOTAL:	1.79	3.77

YALE AND CASCADE JOINT TRACK USAGE
YALE WESTBOUND

	PRESENT RUNNING		ONE WAY OPERATIONS			DELAY	YEARLY SAVINGS (IN MILLIONS)	
CN	NORM	MAINT	NORM	MAINT	DAILY TRAF	SAVINGS /HOUR	PRESENT TRACKAGE	ADDED CROSSOVERS
PASSENGER	2.45	3.47	2.33	2.70	1.0	$843	.10	.11
LOCAL	3.62	3.62	2.85	5.45	.0	$515	.00	.01
FAST FREIGHT	3.13	3.13	2.90	4.15	1.8	$701	.03	.08
SLOW FREIGHT	3.80	3.80	3.07	6.03	3.8	$547	.24	.45
SOLID/UNIT	3.77	3.77	3.12	6.08	3.1	$377	.06	.21
CP								
PASSENGER	2.37	2.38	2.33	2.43	1.0	$843	-.01	.06

FAST FREIGHT	2.82	2.88	2.90	3.03	3.4	$889	-.26	-.14
SLOW FREIGHT	3.03	3.15	3.07	3.42	3.4	$791	-.41	-.14
SOLID/UNIT	3.35	3.53	3.12	4.22	3.2	$894	-.24	.12
						TOTAL:	-.49	.76
CASCADE--EASTBOUND								
CN								
PASSENGER	2.48	2.50	2.33	2.53	1.0	$843	.03	.04
FAST FREIGHT	3.20	3.27	2.56	3.22	1.8	$676	.22	.27
SLOW FREIGHT	3.58	3.73	2.60	3.35	3.8	$644	.74	.86
SOLID/UNIT	3.83	4.00	2.65	4.28	3.1	$444	.41	.55
CP								
PASSENGER	2.43	2.47	2.33	2.53	1.0	$843	.02	.03
LOCAL	2.95	3.07	2.50	3.37	0.2	$580	.01	.03
FAST FREIGHT	2.90	3.00	2.56	3.22	1.8	$851	.11	.17
SLOW FREIGHT	2.98	3.10	2.60	3.35	5.3	$563	.25	.38
SOLID/UNIT	3.27	3.48	2.65	4.28	3.7	$596	.21	.43
						TOTAL:	2.00	2.76
OPERATING SAVINGS--ALL JTU TERRITORY							3.64	9.30
TO CN:							3.87	6.02
TO CP:							-.23	3.28
BY LINE SEGMENT:								
KAMLOOPS TO BOSTON BAR/NORTH BEND							2.16	5.67
BOSTON BAR TO MISSION CITY							1.51	3.45

*ASSUMING CN AND CP TRAFFIC JOINTLY USING TRACKAGE 9 MONTHS OF THE YEAR, AND TRACK SECTIONS BETWEEN CROSSOVERS UNAVAILABLE DUE TO MAINTENANCE FOR 1.5 MONTHS PER YEAR EACH

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direction traffic reduces operating costs considerably, providing savings of approximately $9.3 million per year under present operations. Given construction costs of $56.8 million, this would provide an annual return of 16.4% with present traffic levels. It also provides a positive return to CP, since the benefits from reduced delays now considerably outweigh the costs of longer transit distances and congestion during single track operation.

Assuming no additional crossovers, considerable costs are encumbered during maintenance periods. This could lead to

capacity problems during projected growth is taken into account. While considerabe benefit would accrue from investments in this option, it is problematic as a long term viable alternative. The second scenario, involving the addition of a pair of usuable cross overs provides both a slightly lower return on investment but provides a sufficient cushion for future traffic growth and track outages and considerable returns.

CHAPTER VI
CONCLUSIONS

In this presentations, a number of options for moving rail traffic through area between Kamloops and CN and CP cutoffs to Roberts Bank were explored. Each of these involved total investment of less than $90 Million dollars. Two criteria are utilized in assessing these options:

1) Contributions to capacity, given present traffic projections for this area;

2) Cost savings in terms of reduced requirements for train delays due to meets and overtakes.

A total of five scenarios were explored for CN track and four for CP track. Two in each case involved the joint usage of existing facilities by both railways and one way operation on each existing facility. The others involved expansion of existing plant and separate operations by each railway through combinations of additional sidings, some double tracking and the upgrading of signals and turnouts. A summary of the estimated costs and benefits of the four most attractive options are provided below in Table 22. The CN double limited double track option with no upgrading of turnout speeds is dropped from consideration because of its high cost and limited benefits.

Given the projected traffic levels of between 25 and 28 trains per day in 1995 provided in Table 4, Table 22 indicates that all of the CN projected expansion paths would seem to

TABLE 22
A SUMMARY OF THE COSTS AND BENEFITS OF
SEPARATE OPERATIONS AND LIMITED JOINT TRACK USAGE OPTIONS

OPTION	CAPITAL COST	CAPACITY*	PRESENT USE INTERFERENCE BENEFITS
CN			
PRESENT OPERATIONS	--	25	--
JTU STUDY RECOMMENDATIONS	37.6	31	1.5
MIXED CN/JTU PLAN	77.6	36	1.9
JTU WITH PRESENT TRACKAGE	11.6***	30	3.8
JTU/ADDITIONAL TURNOUTS	26.8	35	6.0
CP			
PRESENT OPERATIONS	--	33	--
JTU STUDY RECOMMENDATIONS	40.7	37	0.9
LIMITED DOUBLE TRACK	87.5	41	1.6
JTU WITH PRESENT TRACKAGE	13.8	38	-0.1
JTU/ADDITIONAL TURNOUTS	31.4	41	3.0

* BASED UPON EXPANSION IN SOLID TRAIN TRAFFIC ONLY AND USE OF JTU STUDY TEAM CAPACITY CONSTRAINTS
** CAPACITY ASSUMES FREE OPERATION ON BOTH TRACKS FOR 75% OF THE YEAR, AND 12.5% UTILIZATION OF EACH OF CN AND CP OPERATIONS
*** CAPACITY AND TRAFFIC APPORTIONED ON THE BASIS OF PRESENT USE

provide sufficient capacity for the next decade. All options also provide some savings in interference costs. The highest percentage payback is provided by joint track usage options, indicating returns in operating savings of over 20% of construction costs. The largest absolute benefits accrue to the joint track usage option with limited numbers of crossovers.

For CP, with projected traffic levels of between 30 and 37 trains per day in 1995, as provided in Table 7, all of the expansion paths also provide sufficient capacity. The JTU option though, provides capacity limits which are very close to upper

bound of the 1995 projections. The returns from the joint track usage option with no crossovers is negative because of the increased mileage traversed by westward moving trains on the CN line and high congestion costs during maintenance periods. Benefits to CP with the addition of crossovers, though are considerably above those of other options and average close to 10%.

Among independent operation options the JTU study team recommendations provide a sufficient capacity base for the next decade and provide some payback on investment dollars for CN operations and the CP Cascade Subdivision. Limited sections of double track is attractive on the CP Thompson Subdivision in providing a sufficient cushion for the optimistic 1995 traffic projections. Given traffic projections through to 1990, and a probable ability to construct this type of expansions in a limited amount of time, it would seem unwarranted to plan for capacity expansion on the CN or CP lines until the beginning of the next decade.

Generally, joint track usage options provided considerably greater capacity and considerably higher paybacks. Utilizing CN track for westbound use and CP track for eastbound use with minor improvements in the system produced a considerable payback but provide potential capacity problems when CN or CP track was taken out of service for maintenance. These capacity problems could, under optimistic growth projections cause problems on the CP Thompson subdivision. Further, with joint track usage and no

additional crossovers, at present traffic levels, the benefits to CP of reducing congestion due to overtakes are outweighed by the combined effects of congestion during maintenance periods and the longer distance that full CP trains would travel over CN track, particularly along the Ashcroft Subdivision.

Improvement of the crossover at Basque and the construction of an additional crossover at North Bend, at the one third and two third points along this route would allow the full time operation of a two track system over two thirds of the system when blended with a co-ordinated maintenance programs, would reduce the impacts of shifting traffic to a single track. Under this scenario, benefit to both CN and CP would be considerable.

In sum, at this point, joint track usage with moderate adjustments to existing trackage and facilities seems to offer a cheap way of increasing capacity in the area has the potential of significantly reducing transit time and associated costs. In estimating the benefits of this option, more work is required to include the required adjustments to CN and CP operations at and just east of Kamloops. With the objective of producing a system which is both adequate and efficient for future railway transport through this area, joint track deserves further consideration.

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FOOTNOTES

1. For example, under limited upgrading of existing lines, the study team recommended additional sidings based on STO capacity and bottleneck estimates. While this method can provide reasonable rough estimates of capacity in many circumstances, it has a number of problems and limitations (See Spector, 1986 pp. 38-40). For example, it emphasizes the analysis of bottleneck track sections without consideration to overall track configuration or train operations. It is not appropriate for the fine tuning required to develop specific capital investment recommendations.
2. CP is presently experimenting with coal trains that run as a number of fully integrated units. Each of these units is composed of a locomotive and approximately 28 coal cars. Trains would be composed of four of these units. In addition, the completion of the Rogers Pass project should lead to a revision, and probably a lengthening of other CP traffic, particularly, solid and unit trains.
3. These schemes incorporate CN's introduction of intermediate signalling and the upgrading of the existing Centralized Train Control system.
4. Signal Costs are developed by using the Unit Costs reported in (Delcan 1985), pp. 10-6 and assume the following construction:

   For each new siding: 2 interlocking #13 turnouts

2 upgrades of field and office coding equipment
2 new locations for intermediate signals
upgrade of track circuitry
2 electric lock locations

For double track: 2 interlocking locations
2 upgrades of field and office coding equipment
new locations for two are intermediate signals at 1.3 mile intervals along double track
upgrade of track circuitry
2 electric lock locations

5. The total costs for CN and CP are $8.6 million short of those produced in the joint track usage study. This difference results from additional signalling and turnout requirements recommended by the JTU study team as follows:

   a) The upgrading of existing connections between CN and CP to allow better control of interchange movements by dispatchers at Kamloops.

   b) the conversion of the existing CP ABS signal system between Ruby Creek and Mission City to Centralized Train Control

   c) The addition of additional hot box and dragging equipment detectors.

   While these are relevant and required costs to implement improved operations in this area, it was felt that these would be implemented at the same cost under any expansion scheme. In additional, the latter two infrastructural improvements are expected to be completed in the near future.

6. The details of the costing methodology used lie outside of

the scope of this report. A Separate report entitled "A Methodology for Assessing Interference Costs" by the author is to be put forward as part of this general series dealing with railway capacity. A similar methodology is described in Wei (1987).

7. This is considerably lower than the capacity estimate provided by the JTU study team of 28-29 trains per day. This lower capacity estimate is primarily a result of the implications of potential secondary delays due to meets and of overtakes. While both situations are possible, dispatching strategies can significantly reduce these potentials.